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Interagency Committee on Ocean Pollution Research, Development, and Monitoring / Federal Coordinating Council for Science, Engineering, and Technology

Working Papers 2-5

August 1979

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PREFACE

In response to the National Ocean Pollution Research and Development and Monitoring Planning Act of 1978, Public Law 95-273, (the Act), the Interagency Committee on Ocean Pollution Research, Development, and Monitoring (Interagency Committee) was created in June 1978 under the auspices of the Federal Coordinating Council for Science, Engineering, and Technology in the President's Office of Science and Technology Policy. The National Oceanic and Atmospheric Administration's Deputy Administrator serves as chairman, and the Environmental Protection Agency's Assistant Administrator for Research and Development as Vice Chairman. Federal departments or agencies having significant involvement in ocean pollution research and development and monitoring represented on the Committee are:

Department of Agriculture
Department of Commerce
Department of Defense
Department of Energy
Department of Health, Education, and Welfare
Department of the Interior
Department of Transportation
Environmental Protection Agency
National Aeronautics and Space Administration
National Science Foundation
Nuclear Regulatory Commission
Council on Environmental Quality
Office of Management and Budget

The Interagency Committee formed four Subcommittees to gather information, make analyses, and develop specific portions of the 5-year Federal Plan for Ocean Pollution Research, Development, and Monitoring--required by Section 4 of the Act--as follows:

National Needs and Problems, chaired by the principal representative of the U.S. Environmental Protection Agency, with responsibility for developing a statement of National needs and problems related to ocean pollution research and development and monitoring based on input from Federal program managers, scientists, industry, public interest groups, State and local government planning agencies, and groups involved in adjudication of environmental issues.

Data Collection, Storage, and Distribution, chaired by the principal representative of the Department of the Interior, responsible for assessing the adequacy of present Federal efforts in this area and making recommendations to the Interagency Committee on design of a system to make better use of the results of Federal ocean pollution research and development and monitoring in decisionmaking processes relating to development and conservation of ocean resources.

Monitoring, chaired by the principal representative of the Department of Commerce, responsible for assessing the adequacy of present Federal efforts in ocean pollution monitoring and making recommendations to the Interagency Committee on necessary changes to the program.

Research and Development, chaired by the principal representative of the National Science Foundation, responsible for assessing the adequacy of present Federal efforts in ocean pollution research and development and making recommendations to the Interagency Committee on necessary changes to the program.

The subcommittee reports are presented in this document as Working Papers 2-5 for the Federal Plan for Ocean Pollution Research, Development, and Monitoring, Fiscal Years 1979-83. Working Paper 1, a separate volume, is the Catalog of Federal Ocean Pollution Research, Development, and Monitoring Programs, Fiscal Years 1978-80. Working Paper 6 is the "Proceedings of Workshop on Scientific Problems Relating to Ocean Pollution," Estes Park, Colo., July 10-14, 1978 (NTIS Accession number PB 297 467-A11). Working Paper 7 is the "Proceedings of Workshop on National Needs and Priorities of Ocean Pollution Research and Development and Monitoring," Tyson's Corner, Va., November 14-16, 1979. Working Papers 1-7 form the basis for the analysis done to prepare the Federal Plan for Ocean Pollution Research, Development, and Monitoring, Fiscal Years 1979-83. The Federal Plan and working papers are sold by the National Technical Information Service (NTIS) in paper copy and microfiche. Orders should be directed to NTIS, 5285 Port Royal Road, Springfield, VA 22161 (telephone: 703-557-4650). When ordering, give NTIS accession number.

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First Report of the Subcommittee on National Needs and Problems

Working Paper 2
May 15, 1979

Stephen J. Gage
Subcommittee Chairman

Interagency Committee on Ocean Pollution Research, Development, and Monitoring

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Federal Coordinating Council for Science, Engineering, and Technology

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FOREWORD

Identification of national needs and priorities for ocean pollution research and development and monitoring has been a great challenge. To write this synopsis, the Subcommittee sifted through great volumes of reports, workshop proceedings, books and personal communications on ocean pollution study needs, combined like needs, and put them in social and scientific perspective. Those many persons who cared enough about the well being of the oceans to offer their time and thought and effort have been our greatest resource in this task, and we are grateful to them. Their names appear as participants in the Estes Park and Tysons Corner Workshops, and as members of the Subcommittee, all in documents which accompany this report.

Point Lobos, California (EPA, Documerica).

The Subcommittee report is a good faith effort to represent the needs of all of the users of ocean pollution studies. Our scope of inquiry included federal, state, and municipal officials, representative public interest environmental groups, industrial officials, and persons involved in the adjudication of ocean pollution disputes. In an attempt to break the tradition of considering ocean pollution study as a purely ocean science enterprise, we have included lawyers, economists, journalists, and other social scientists in our inquiry.

The actual needs are stated in terms of their social utility, and are described in social perspective wherever possible. There is disagreement about some of these value judgements, and some needs presented below are matters of present public controversy or litigation. They remain needs for information, whatever is the argument.

The needs presented are organized by ocean use category to be judged each on its merits. Assigning priority to needs for information on ocean pollution has been a particularly difficult task, only slightly mitigated by the realization that priorities change with time and circumstance. The ordering suggested in this report reflects our thinking in the late winter and spring of 1979. It should be opened to questioning periodically throughout implementation of the plan for ocean pollution studies.

Stephen J. Gage
May 15, 1979

INTRODUCTION

BACKGROUND

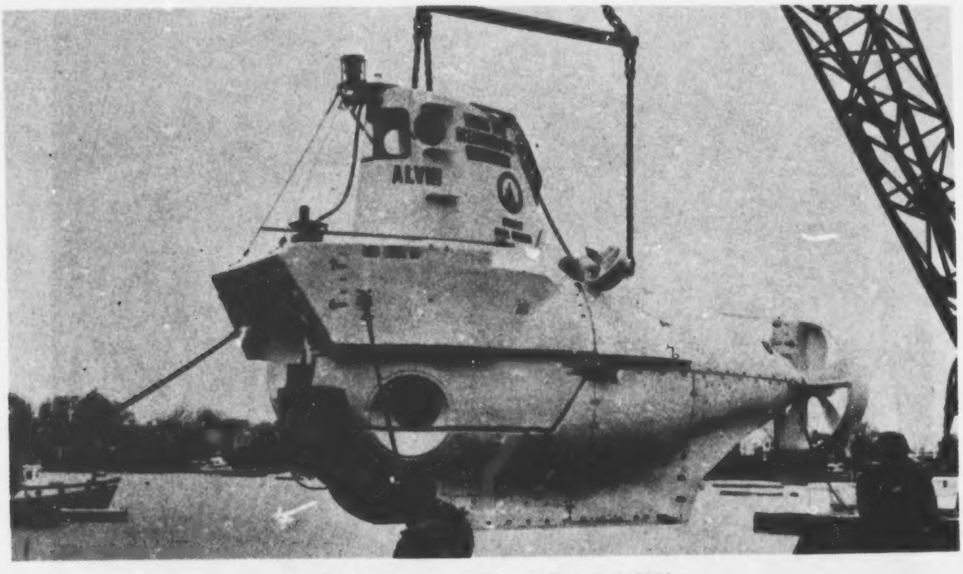
Congress passed the Ocean Pollution Research and Development and Monitoring Planning Act (PL 95-273) on May 8,1978. This legislation called for establishment of a comprehensive five year plan for Federal ocean pollution research and development and monitoring, emphasizing coordination among the concerned Federal Agencies. The National Oceanic and Atmospheric Administration (NOAA) in consultation with the Office of Science and Technology Policy (OSTP) was designated lead agency in this endeavor.

The development of such a comprehensive program is an enormous task. To accomplish it, OSTP created the Interagency Committee on Ocean Pollution Research and Development and Monitoring under the Federal Coordinating Council on Science, Engineering and Technology. This Committee was charged with: identifying national needs and problems, establishing priorities, determining existing Federal programs and capabilities, and recommending changes in the overall Federal ocean pollution research and development and monitoring effort. Four subcommittees were established in July 1978 to help the committee successfully complete its task. They were: National Needs and Priorities, Research and Development, Monitoring, and Data Handling.

SUBCOMMITTEE ACTIVITIES

The Subcommittee on National Needs and Priorities took Section 4(b) (1) of the law as its charter. This Section calls for an assessment and ordering of needs. Representatives from the U.S. Environmental Protection Agency, National Ocean Atmospheric Administration, Department of the Interior, Department of Transportation, National Science Foundation, Department of Energy, Council on Environmental Quality, Department of Health Education and Welfare, National Aeronautics and Space Administration, Nuclear Regulatory Commission, Department of Agriculture and the Department of Justice participated in Subcommittee activities. This report is the result of those activities.

The primary purpose for many federal ocean pollution research and development and monitoring programs is to provide information to those who make policy and management decisions affecting man's uses of the oceans. Data themselves do not convey information. Data together with their reasoned analysis, translated into simple language are useful in choosing options or in



The Deepsea Submersible "Alvin" (NOAA).

regulating the choices. Thus, in identifying needs and priorities which would ultimately lead to better planning of the federal program in these areas, the Subcommittee consulted the users of ocean pollution research and development and monitoring. These included both the regulators and the regulated.

Policy level representatives from Federal, State and local governments, adjudicators, as well as representatives from industry and environmental groups and scientists voiced their concerns.

The Subcommittee carefully considered the results of the July 1978 Estes Park Workshop, a gathering of scientists, whose task was to examine the state-of-the-art and suggest a marine pollution research and monitoring program. This information was complemented by the November 1978 Workshop on National Needs and Priorities for Ocean Pollution Research and Development and Monitoring held in Tysons Corner, Virginia. Participants in this endeavor represented a variety of disciplines, among them law, economics, and social sciences, as well as the more traditional marine sciences. Finally, the Subcommittee drew upon its own expertise to identify gaps and to cite those activities necessary to carry out legislative mandates.

NEEDS

The needs presented in this report are thus a synthesis of those identified by the sources listed above. They are organized according to ocean use category, i.e., Energy, Waste Disposal, Transportation, Mineral Resources, Living Resources, Recreation and Land Use Practices. Scientific, technological, legal, economic and sociological factors associated with preventing or abating pollution in the marine environment have been considered for each topic area. The needs are thus very general.

The Subcommittee assumed that basic research in oceanography and estuarine systems dynamics was not part of its mandate, since basic research is not specifically directed toward any of the applied problems examined by the Subcommittee. Studies of oceanographic and hydrological phenomena will contribute to the ocean pollution research, development, and monitoring efforts recommended in the report. However, basic research serves broader objectives, and its use in wiping out ocean pollution is but one of its justifications.

SETTING PRIORITIES

A systematic approach should be used to evaluate needs and set priorities. Realizing this, the Subcommittee conducted a preliminary survey of ocean use activities and the associated need for research, development and monitoring in each area. The factors considered were:

- Immediacy of the pollution threat
- Value and importance of the activity to society and the economy
- Intensity of the polluting activity
- Distribution of the activity (local, regional, global)
- Value and vulnerability of resources at risk
- Likelihood of solving the problem in the near term, taking into consideration the availability of scientific expertise and cost-effectiveness

The Subcommittee members ranked each ocean use activity over a range of five levels from

Coastal Development, Newport Beach, California (EPA, Documerica).

the least to the most significant. Several members (e.g., EPA, DOI) contributed average scores which represented rankings made by several experts within their respective agencies. The ranking of the summed score for all criteria by each ocean use and agency provided emphasis for study. The results of the survey are presented in Table 1 as a general banding of high medium and low priority areas. Activities within each category are listed alphabetically. No ordinal significance is intended.

The ordering of these diverse ocean polluting activities and their related study needs is judgemental. It represents consensus views of Subcommittee members acting upon their personal expertise in their ocean speciality and knowledge gained in their many discussions with diverse users of ocean pollution study results. These priorities are expected to change with time. Agency mechanisms for reordering priorities are expected to act upon them throughout the implementation of the plan. This ranking process is considered, at best, a rough approximation. Thus, results should be interpreted within broad limits. The process should be further refined and formalized for future rankings.

TECHNICAL STUDY AREAS

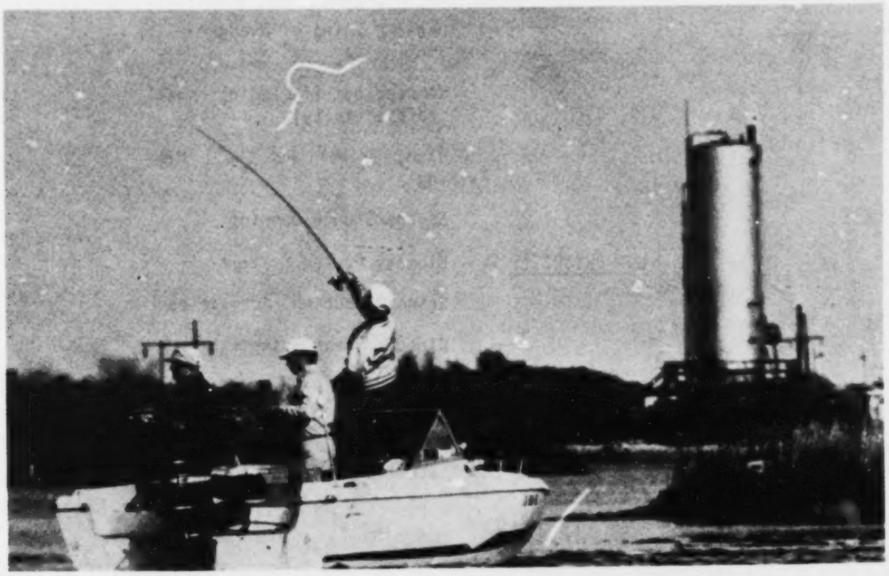
The Subcommittee also tried to determine the emphasis which should be placed on certain technical study areas over the next five years. The study areas considered were:

- Control technology
- Environmental transport (both physical and biological)
- Transformation (both chemical and biological
- Ecological/biological effects
- Direct human effects
- Measurement methods
- Habitat modification

As in the survey conducted to set priorities, the Subcommittee members ranked each ocean use category over a range of five levels from the least to the most important. The numerical score averaged for each ocean use activity by technical study category provided an opportunity to observe the pattern of recommended study emphasis.

The results of this survey indicate that for all the ocean use activities no one technical study area received major emphasis; all were of moderate importance. However, for those ocean use activities which ranked high in the previous exercise, all the technical study areas received greater emphasis. The results are presented in Table 2.

This ranking process is only a rough approximation based upon value judgements made by the participants in the exercise. The Subcommittee recommends refinement of the process for future endeavors.



Louisiana Fishermen with Natural Gas Well in Background (EPA, Documerica).

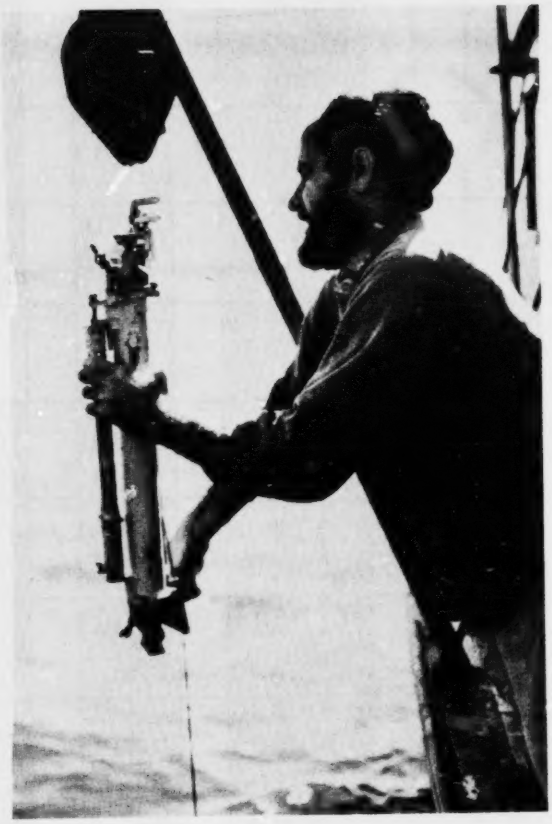
TABLE 1. RESEARCH PRIORITIES FOR MARINE ACTIVITIES

	ACTIVITY
HIGH PRIORITY:	Industrial Waste Disposal
	Land Use Practices
	Municipal Sewage Outfalls
	Oil and Gas Development
	Oil Transportation
	Steam Electric Power Plants
	Transportation of Hazardous Material
MEDIUM PRIORITY:	Deep Seabed Mining
	Fish and Shellfish Processing
	Hatcheries and Aquaculture
	Ocean Dumping of Dredged Spoil
	Recreation (including small craft activity)
	Sand, Gravel and Shell Mining
	Sewage Sludge Dumping
LOW PRIORITY:	Biomass Fueled Systems
	Brine Producing Activities
	Kinetic Ocean Systems
	OTEC
	Salinity Gradient Systems
	Satellite Power Systems

TABLE 2. PRIORITY TECHNICAL STUDY AREAS BY MARINE ACTIVITIES

	OCEAN USE ACTIVITY	CONTROL TECHNOLOGY	ENVIRONMENTAL TRANSPORT		TRANSFORMATION		ECOLOGICAL/ BIOLOGICAL EFFECTS	DIRECT HUMAN EFFECTS	SOCIO-ECONOMIC EFFECTS	MEASUREMENT	HABITAT MODIFICATION
			PHYSICAL	BIOLOGICAL	CHEMICAL	BIOLOGICAL					
HIGH	INDUSTRIAL WASTE DISPOSAL	▨	▨	▨	▨	▨	■	▨	▨	▨	☐
	LAND USE PRACTICES	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	MUNICIPAL SEWAGE OUTFALLS	▨	▨	▨	▨	▨	▨	☐	☐	☐	☐
	OIL AND GAS DEVELOPMENT	▨	☐	☐	☐	☐	▨	▩	▨	▨	☐
	OIL TRANSPORTATION	▨	☐	☐	☐	☐	▨	☐	▨	▨	☐
	STEAM ELECTRIC POWER PLANTS	▨	☐	☐	☐	▩	▨	☐	▨	☐	☐
	TRANSPORTATION OF HAZARDOUS MATERIALS	▨	▨	▨	▨	▨	▨	▨	▨	☐	☐
MEDIUM	DEEP SEABED MINING	☐	▩	▩	▩	▩	▩	▩	▩	▩	▩
	FISH AND SHELLFISH PROCESSING	▩	▩	▩	▩	▩	▩	▩	▩	▩	▩
	HATCHERIES AND AQUACULTURE	▩	▩	▩	▩	▩	▩	▩	▩	▥	▩
	OCEAN DUMPING OF DREDGED SPOIL	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	RECREATION (INCLUDING SMALL CRAFT ACTIVITIES)	▩	▩	▩	▩	▩	▩	▩	▩	▩	▩
	SAND, GRAVEL AND SHELL MINING	☐	▩	▩	▩	▩	☐	▩	▩	▩	☐
	SEWAGE SLUDGE DUMPING	☐	☐	☐	☐	☐	▨	☐	☐	☐	☐
LOW	BIOMASS FUELED SYSTEMS	▩	▩	▩	▩	▩	☐	▩	▩	▩	▩
	BRINE PRODUCING ACTIVITIES	▩	▩	▩	▩	▩	☐	▩	▩	▩	▩
	KINETIC OCEAN SYSTEMS	▩	▩	▩	▩	▩	▩	▩	▥	▩	▩
	OTEC	☐	☐	▩	▩	▩	☐	▩	▩	▩	☐
	SALINITY GRADIENT SYSTEMS	▩	▩	▩	▩	▩	▩	▩	▥	▩	▩
	SATELLITE POWER SYSTEMS	▩	▥	▥	▥	▥	▩	▩	▥	▩	▩

■ MOST IMPORTANT ▨ IMPORTANT ☐ MODERATELY IMPORTANT ▩ OF SOME IMPORTANCE ▥ NOT VERY IMPORTANT



A Water Sampler Designed to Operate at Prescribed Depths (EPA, Narragansett Environmental Research Laboratory).

INTERDISCIPLINARY NEEDS

Certain needs for information transcend ocean use or academic disciplinary boundaries and will appear as needs no matter what aspect of ocean pollution is considered--or who is considering it. These are needed for choices made by industries and public interest groups, drafting and enforcing legislation, regulations and guidelines, applying for and issuing permits, and planning for the future well-being of the oceans.

Interdisciplinary needs are singled out for special emphasis here even though they are woven through the following descriptions of study needs related to ocean uses. This special emphasis is deserved because several federal agencies are concerned with each of these needs, but only to the extent that a need relates to an individual agency mandate, and only using individual agency resources.

Decision Analysis

Several issues of option analysis should be resolved beyond mere method development and validation. The most important is that of breadth of the analysis. A corollary issue is fragmentation of the analysis and severability of its parts. Then there are the twin issues of methods development and incommensurables. If these four issues can be dealt with successfully, we shall have solved the problem of inadequate analysis.

Breadth of the analysis is critically important to its value in choosing an option. Whole systems need to be considered--not just the risk of one ocean pollutant contacting and damaging one resource. Thus, in deciding whether a thermal discharge requires a cooling tower to mitigate its heat effects on the receiving water, one also must factor in the polluting effects of the cooling tower, going back to the coal or oil used to make its bricks (elsewhere), the transport of materials and workers, construction effects, as well as its own operational effluents and fuel penalties. One may decide that the cooling tower is the greater evil or that the whole facility is planned for an unacceptable site and should be built elsewhere. Analyses even of this scope are rare under NEPA's mandates, but they could be broader still and used in combination to seek new options. For example, in examining land based alternatives to sewage sludge dumping at sea, one could analyze the transportation needs of eastern cities, the sludge production of eastern cities, the farm fertilizer needs of western food and timber producers, and the economic needs of the railroad industry--all toward developing an integrated, economically advantageous solution to an ocean pollution problem. Perhaps this is a poor example but it may not be, and certainly no executive agency presently is using this broad a scope of inquiry and analysis.

We need to compare starfishes with sea cucumbers when oil and water mix. This is the problem of incommensurables, the non sequiturs of economic analyses. Not everything that we need to factor into risk analyses reduces to economic terms. Aesthetics and recreation, discussed below, have more value to society than is expressed by dollars that people are willing to pay or can afford. Still, we need to employ methods to relate values measurable in dollars to values measurable in other units, such as increased summer violent crime when urban recre-

A Principal Migratory Bird Stop in California Slated for Development (EPA, Documerica).

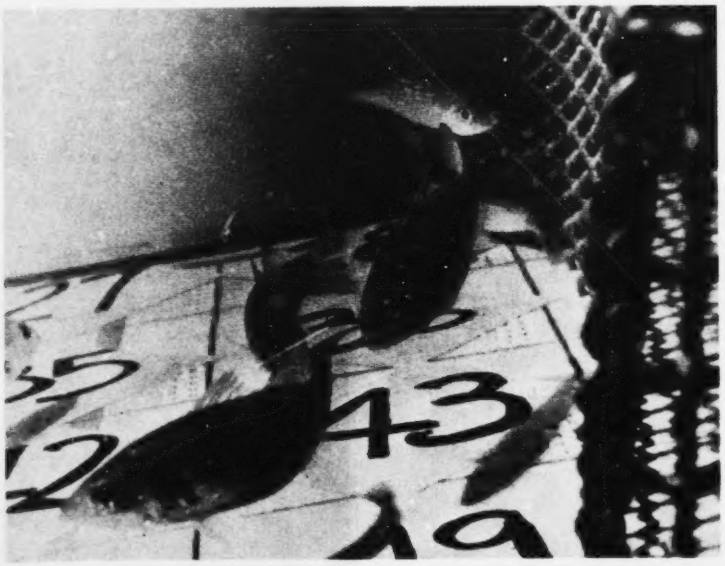
ational beaches are closed due to bacterial pollution, or the effect that the wetlands of Glynn County, Georgia had on Sidney Lanier and the readers of his "Marshes of Glynn." These may seem strange matters for federal officials to deal in, but the consequences of federal decisions occur anyway and means must be devised to factor societal values into the choice of ocean use alternatives. Thus, we should include economists, planners, and other social scientists to a greater extent than we have in wiping out ocean pollution.

Last, we need means to determine how much uncertainty may be tolerated in reaching decisions about ocean pollution. This is particularly necessary where decisions involve a high risk option with a low probability of occurrence. Acceptable levels of uncertainty should be addressed, or at least means should be found to describe the limitations of information that was used to make choices. That should enhance the accurate translation of science into public policy, and should assure that the research effort expended on any question is approprfate to its importance.

Measurements, Standards, and Intercalibration

For many practical and theoretical reasons, we need to detect the presence and measure the concentration of pollutants in the ocean's aquatic, biological, and solid parts. This is difficult because very small concentrations of pollutants can be important, sample sizes often are limited, and the ocean is a dilute and variable solution of naturally occurring salts and organic chemicals which interfere with analyses. Analytical chemistry grew into a science in the laboratory, where experimental mixtures can be controlled, and is ill equipped for transfer to the field because of tradition and methods. Considerable improvement has been made in this situation over the past three decades, but much more improvement of analytical method is needed to (1) increase the numbers of samples that can be analyzed, particularly for organic pollutants, and (2) bring down the cost of each analysis. In addition, the accuracy and precision of organic analysis of marine materials lags far behind that achieved for inorganic analyses. Further, the cost per sample is much higher for organics, and the numbers of persons and laboratories capable of performing organic analyses with acceptable accuracy and precision are miniscule, by any standard. Analytical capability available to U.S. students of ocean pollution problems distinctly limits our ability to make intelligent choices concerning ocean resources.

Many of our ocean pollution regulations are based on the prudence of assuming that laboratory results mirror what may be expected of a pollutant in the ocean. Although a prudent approach to ocean resource use is wise, it is not in itself a solution to the problem because it may lead to unnecessary costs of resource use to burden the consumer. Therefore, case specific ocean validation of laboratory data used in regulating ocean use should be performed for all materials and processes that are regulated based upon laboratory data. For many of these materials and processes, the same limitations that prevented field analyses in the first place still apply. These must await necessary analytical developments. However, a plan for research and development and monitoring should be developed toward the goal of determining the real importance of each regulated pollutant in the marine environment.



Juvenile Striped Bass Undergoing Activity Tests in Presence of Pollutants (DOE).

MARINE ENERGY

STEAM ELECTRIC POWER PLANTS

During the past decade the electric power industry and the government have built a solid foundation of ecological research information on which to make decisions about cooling water uses in the marine environment. The regulators and regulated have worked in concert, if not always in harmony, to bring us to a set of regulatory principles which differ considerably from those of a decade ago. Regulatory concern has shifted from discharge temperature to adverse effects of the intake on small creatures passing through the plant in its cooling water; from size of the discharge mixing zone to actual effects of effluent on the balance of species in the surrounding ecological community; and from pure regulation of effluent characteristics to technological means of lessening adverse effects of the whole cooling water system. The electric power industry, by broadening its ecological knowledge and awareness, has developed technologies and practices which now allow plant siting in a few places which would be environmentally unacceptable using old operating practices. These technologies and practices have their own environmental costs and benefits, which simply provide another option to consider. Technology is the area in which research and development are most needed to contribute to future operations and siting decisions concerning steam electric power generation.

Development of Selective Intake Technology

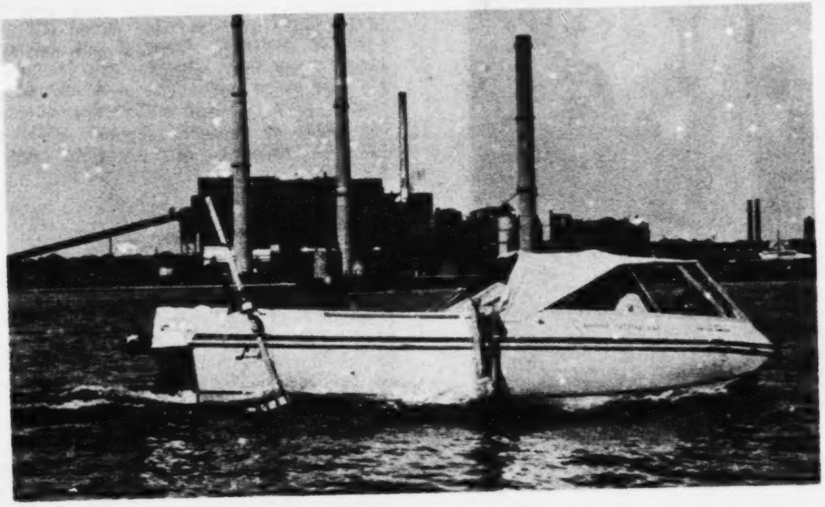
The young of commercially and ecologically important marine species need to be kept from passing through cooling water systems. Where siting in spawning and nursery areas can not be avoided due to economic, jurisdictional and engineering reasons, means to minimize their exposure to the generating plant need to be developed, tested, refined, and put in place at new and some existing problem sites.

Development of Discharge Technology

Shallow water sites and shorelines are the greatest technological challenge to protect. Offstream cooling and diffusion technologies need to be made more effective and less expensive to build and operate. Means to reject heat directly to the air in larger amounts than presently is possible are needed. Use of presently wasted heat for other purposes needs to be transplanted from Europe to the U.S. technological arsenal. Application of cogeneration, the use of steam produced to generate electricity for additional purposes, should be re-examined.

Determination of Far Field Effects

An unresolved issue in several steam electric plant adjudicatory proceedings has been the extent to which cooling water damage to the

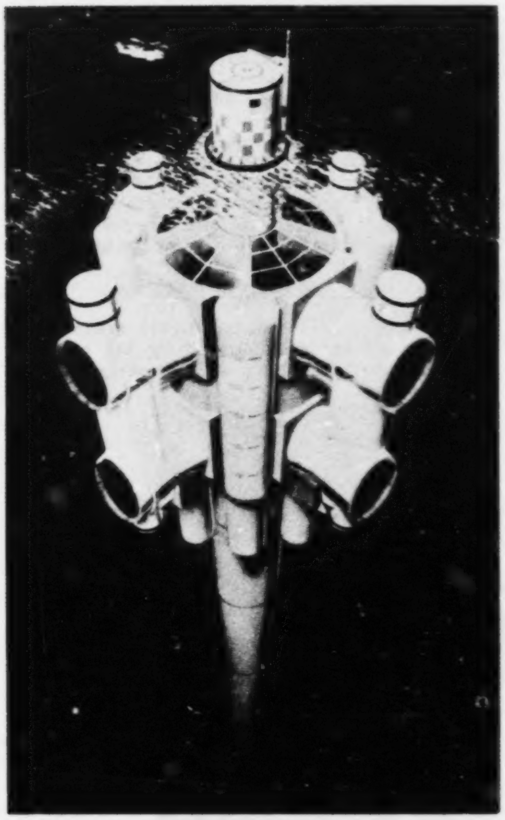


Measuring Dispersion of Thermal Effluent From a Coal-Fired Power Plant (DOE).

young of commercially, recreationally, and ecologically important species affects the abundance and distribution of the adults. Better methods to measure initial damage, follow exposed animals through life history stages and migrations, and measure adult population sizes and distributions are needed. Alternatively, a policy that any field damage is unacceptable would accomplish the same environmental protection--but it trades lesser cost to the taxpayer for greater cost to the consumer.

Cumulative and Individual Risk Assessment Methods Development

Considerable research and preoperational monitoring has attended each National Pollutant Discharge Elimination System (NPDES) permit issued to a coastal or estuarine power plant. Thus a lot of data and professional judgement are available. What are the cumulative effects on the marine environment of additive stresses from cooling water use, alone and in combination with other stresses? For individual steam electric generating facilities and for multiple generating facilities which affect the same water body, the questions of cumulative effects remain. Data and expertise are available to answer them and should be applied to doing so.



One Concept For a Power Station Utilizing Thermal Ocean Gradients. Turbine generators, producing 160 megawatts of power, ring a core 250 feet in diameter and 1,600 feet long (Lockheed Corporation).

OCEAN THERMAL ENERGY CONVERSION

The OTEC concept requires ocean siting in areas deep enough to have a thermal gradient at constant depth. Presently conceived OTEC technology would require that areas having a shallow continental shelf place OTEC generating units far offshore, which may eliminate shallow areas due to the economics and technology of underwater electric transmission. Early OTEC experiments are scheduled for insular and deepwater Pacific trials only.

OTEC may not cause pollution in the oceans. However, it would be imprudent to suppose so and therefore not to look for pollution in field trials of small pilot plants. Certainly the chemical and physical basis for biological effects is present, even in deep waters that are sparsely populated with plants and animals, if those waters are close enough to shore to mix with abundantly populated inshore waters. To that extent, research is important to evaluating the environmental and economic costs and benefits of OTEC.

BIOMASS FUELED SYSTEMS

Undersea forests are known to grow faster than those on land, and so have a potential as industrial fuel. Pilot studies of kelp farming for this purpose have begun, and require research evaluation both in underwater phases and in the fuel cycle phase of developmental technology. Research and development must concern itself with air and water pollution potential of undersea farming and harvesting, processing the fuel species into burnable form, and air and water pollution problems of burning the fuel itself. These activities should receive a low level of resource support until energy production results of exciting magnitude are achieved.

KINETIC OCEAN SYSTEMS

The appeal of tidal, wave and current forces to generate electricity lies in their freedom from fuel requirements. Their difficulties stem from that also, because society is technologically and intellectually ill-equipped to harness diffuse energy sources and convert them into concentrated usable form. Thus we know more about tidal energy than about wave energy and we know least about uses of ocean currents. However, technology exists for commercial tidal generation and wave forces have produced electricity in European field experiments. Only current forces remain purely hypothetical in 1979.

Tidal Generation of Electricity

Freshwater impelled turbines power dynamos wherever in the U.S. there are large waterfalls or dams. In saltwater estuaries and fjords of considerable tidal range, such as those of the North Atlantic and Pacific northwest states, similar dam projects can be engineered to produce electricity using a dammed up, saltwater hydrodynamic force to spin a turbine. The proposed international Passamaquoddy Power Project at the maritime border of Maine and Quebec has been an engineering possibility planned since the 1930's and was denied then only through political and economic controversy. As finite fuel supplies become more precious, infinite force mechanisms become more likely, and in the next five years, some resources should be devoted to re-examination of their practicality and to a new assessment of their potential to damage or disrupt the marine environment.

The Rance Tidal Power Station on the Brittany Coast is Man's First Effort to Generate Electricity From Tidal Flow (DOE).

Materials Developments for Saltwater Turbine Systems

Inventions in metallurgy developed since the original 1930's tidal power systems designs were put away should be applied to modernize the designs. New cost estimates should be developed both for governmental and private development of a specified tidal power project.

Environmental Assessment of a Tidal Power Project

Original plans for tidal electric generation did not include an assessment of environmental effects. Large impoundments of seawater change high energy to lower energy ecological systems. Entrainment, entrapment, and impingement of fishes and invertebrates, anti-corrosion anode problems, and other more societal and economic impacts should be assessed. It would not be premature to use the NEPA environmental impact assessment process in a predictive mode--as a feasibility study of one tidal power proposal. This too is recommended.

SALINITY GRADIENT SYSTEMS

Marine pollution effects from salinity gradient systems are not expected to occur for the duration of this plan, and require only minor consideration concurrent with development of salinity gradient technology. Only when salinity gradient electric generation field trials are scheduled for the oceans should pollution research, development, and monitoring be planned to accompany them.

SATELLITE POWER SYSTEMS

Ocean pollution effects of satellite power systems receptor fields located offshore are not likely during the next five years. Consideration of ocean effects of satellite generation devices should remain with their developers until some reasonable likelihood of ocean pollution problems arises.

Sludge Dumping in New York Bight (EPA, Documerica).

MARINE WASTE DISPOSAL

SEWAGE SLUDGE DUMPING

National policy under the Marine Protection Research and Sanctuaries Act (PL 92-532)--to phase out almost all ocean dumping of sewage sludge by 1981--is nearly implemented as of 1978. Therefore, the research, development and monitoring needs described below should be restricted to existing disposal sites used for sewage sludge, and should be related to present and pending litigation. A relatively low level of research, development, and monitoring resources are recommended to meet these needs, and it is anticipated that they shall be met during the initial five- year planning period.

Barges Transport New York City Garbage Down East River to Overflowing Landfill on Staten Island (EPA, Documerica).

Pollution Identification

Complete the chemical identification of sludge pollutants at existing sludge dumpsites.

Pollutant Transport and Fate

Complete oceanographic studies of fractionation, dispersion and distribution of sludge pollutants within the water column and bottom sediments.

Metal and Synthetic Pollutants

Complete studies of bioaccumulation of heavy metal and synthetic organic pollutants attributable to sludge dumps.

Environmental Rehabilitation

Perform ecosystem recovery studies at representative phased-out dumpsites to determine time and degree of recovery, and residual pollutant abundance, distribution and ecological effects. Identify possible and probable pathways to human exposure.

Risk to Human Health

Perform a risk assessment of human health consequences of sludge dumping at sea in such terms as can be compared to similar risk analyses of land disposal practices.

MUNICIPAL SEWAGE OUTFALLS

In addition to development of advanced sewage treatment technologies and alternative disposal methods, the 1977 Federal Water Pollution Control Act Amendments (PL 95-217) require monitoring and evaluative comparison of coastal and insular municipal outfalls exempted from secondary sewage treatment requirements. This monitoring is required for a five year period--the duration of each allowed exemption. In 1983, renewal of the exemptions will depend upon analyses of the monitoring data. For renewal, the analyses of data must demonstrate that the outfall in question produces no adverse impact on the balance of the ecological community surrounding it. The outfall must continue to meet other chemical effluent standards established in the law. Present regulations governing sewage outfalls temporarily are those used for ocean dumping, and information specific to outfalls needs to be developed into regulations governing them. Research, development, and monitoring needs for municipal sewage outfalls, including those which discharge mixed domestic and industrial wastes, are as follows:

Pollutant Movement and Alteration

Information is needed on chemical and physical processes which disperse, concentrate, and cycle municipal waste pollutants in the ocean. Knowledge of these processes is needed to evaluate and determine conditions necessary for discharge permits under EPA's NPDES program. Facts concerning inshore chemical and physical processes can be used to improve the scope, accuracy, and precision of predictive evaluation of discharge permit applications. Predictive evaluations need to include natural episodic phenomena such as extreme wind and wave conditions which affect pollutant distributions. Study areas of emphasis should include sources, transport, fate, ecological effects, and possible pathways to human exposure.

Synthetic Pollutants

We should determine the source, distribution, persistence, and bioaccumulation of synthetic hazardous chemicals in the marine environment, including food web transfers and possible pathways to man. Chlorination products from antifouling and disinfection processes should be included in this investigation.

Environmental Rehabilitation

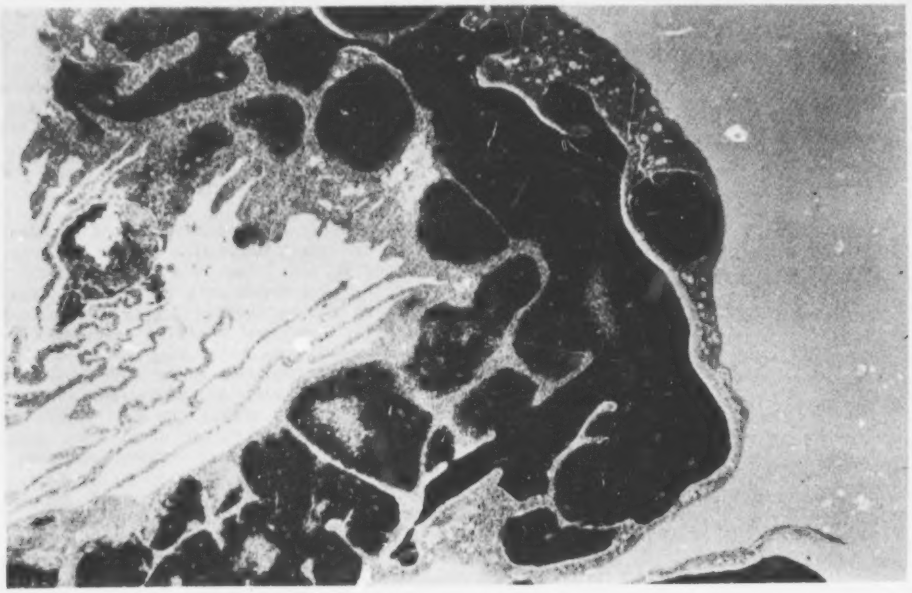
We should determine the efficiency and value of differing sewage treatment practices and choose among them; studies of the degree and rate of recovery of outfall polluted environments after treatment is applied or discharges are removed should be performed. Monitoring strategies should be designed and applied in accordance with those mandated in PL 95-217, Section 301(h). Rehabilitation technologies should be planned, developed, and tested.

Biostimulant Research

Municipal sewage outfall discharges contain large amounts of biostimulant nutrients which could overload the nutrient assimilation capacity of the receiving waters. Natural differences in nutritional characteristics of marine ecosystems and seasonal variations occur as well. To improve our ability to choose waste treatment strategies and outfall sites, we must be able to evaluate nutrient characteristics of particular inshore marine ecosystems, separating natural from manmade variations and accurately determining the degree and persistence of change that any proposed municipal discharge is likely to produce. Evaluations should include ecological and economic effects as well as sources, dispersion, persistence, abatement technologies, and risk assessment protocols.

Sediments

We need to develop standard methods and criteria for evaluating sediment quality so that we can choose suitable treatment technologies and strategies. Knowledge of polluted sediment effects upon diverse marine ecosystems such as coral, seagrass, kelp, and bottom invertebrate systems is needed. Migratory fishes and groundfishes in coastal waters are affected by polluted sediments also, and these effects require ecological and economic evaluation as well.



Microscopic Examination of Marine Organism Tissue Sections Reveals Pathologic Changes Caused by Pollutants (EPA, Narragansett Environmental Research Laboratory).

Microbial Pollutants

Municipal sewage outfalls cause health and ecological risks by introducing microorganisms into the marine environment. These risks must be determined. Areas of research, development, and monitoring include sources, identification of dangerous species, persistence, transformation, measurement, diagnosis of health and ecological effects, development of risk protocols, and prevention of microbial contamination of the marine environment. Costs and benefits of abatement and prevention technologies should be determined.

Municipal Waste Treatment Technology Improvement

We need to reduce the volume and kinds of pollutants which reach the ocean. To do this, advanced alternative waste treatment technologies need to be developed, particularly for geographic areas of immediate hazard such as connecting channels of the Great Lakes and broad continental shelf zones of the Atlantic and Gulf coasts. Technological, ecological and economic costs and benefits of such technologies should be determined at the pilot feasibility stage or before.

Monitoring Strategies

Monitoring sewage outfall effects in marine waters traditionally has been a one-at-a-time , Biological Oxygen Demand and suspended solids and floatables effort, which has ignored the individual and cumulative effects of outfalls upon larger water masses and the ecosystems within them. New monitoring strategies to include these larger considerations need to be developed and implemented, together with tactical means of remedial action based upon the information obtained. Areas requiring immediate scientific improvement for this effort are analytical quality control methods, standardization of techniques and protocols, selection of sentinel species, and development of pollutant analysis methods for marine living and non-living materials.

INDUSTRIAL WASTE DISPOSAL

Industrial wastes differ among industries, among industrial processes for manufacturing the same material, and even differ from time to time out of the same outfall pipe (e.g., batch processing). These differences coupled with ecological and hydrological site differences, necessitate case-by-case consideration to administer the NPDES permit program for industrial wastes. For permitting purposes, commonalities within an industry or among industries using similar processes are useful, but cannot be counted upon if there is not a great deal of specific information on the kind, amount, transport, transformation, fate, and effects of industrial waste in the ocean environment. The following needs relate to information identified as necessary for evaluating methods, costs, and benefits of industrial waste regulation.

Synthetic Pollutants

Research and monitoring should be conducted to determine the sources, distribution, persistence, and bioaccumulation of synthetic materials in the marine environment, including food

Construction Rubble Loaded on Barges in East River, New York, To Be Dumped Offshore in the New York Bight (EPA, Documerica).

web transfers and possible pathways to human exposure. Accidental chlorination products and radionuclides should be included with those synthetic materials deliberately discharged into saltwater environments.

Rehabilitation of Industrially Polluted Environments

Both ecological and economic analysis of degree and speed of recovery of industrially polluted ocean environments should be conducted. Persistent and nonpersistent materials, including radionuclides should be considered separate categories for this purpose.

Industrial Biostimulants

Certain industrial waste discharges are rich in carbon, nitrogen, and phosphorous compounds which act as nutrients in the marine environment, much as do domestic sewage wastes. Some pharmaceutical manufacturing and food processing wastes also are high in nutrients derived from discarded living matter. The ecological and economic effects of these wastes should be identified clearly and quantitatively, as should the costs and benefits of existing and developmental abatement technologies. Information derived in these research and development activities should be included in predictive risk assessment methods which are under concurrent development.

Dead Menhaden Float Behind Tideline in Chesapeake Bay (EPA, Documerica).

Industrial Outfall into Chesapeake Bay (EPA, Documerica).

Prevention Technology

Pretreatment is required for many industrial wastes discharged into publicly-owned treatment works. Others, which discharge separately from municipal waste systems directly into our waters must meet effluent regulations. These regulations all are based upon technology--best available treatment--and not necessarily upon ecological considerations or externalities of economics. Therefore, "to restore and maintain the physical, chemical, and biological integrity of our nations' waters, "(PL 92-500, section 101(a) we need to reduce the volume and number of pollutants reaching the oceans. New and more cost effective technology to remove pollutants from industrial process waste streams should be developed on a process-by-process basis. In addition to technological solutions, alternative disposal strategies including marketing wastes for other uses need be analysed.

Advanced Disposal Technology

We should develop methods which will permanently destroy or isolate very hazardous wastes, including radionuclides. Land-based destruction methods might have obviated the Kepone, PCB, and PBB problems which we now must solve. In the future, adequate isolation techniques may re-open the question, now closed by law, of ocean disposal for high level radioactive wastes and other presently prohibited waste materials.

Human Health

- We should evaluate the health effects of persistent pollutants, including nuclear waste

EPA Biologist Taking Bottom Samples as Part of Systematic Study of Baltimore Harbor (EPA, Documerica).

in the ocean environment and determine active pathways to human exposure.

Monitoring Strategy

A nationwide monitoring system to detect the appearance and persistence of hazardous materials that are accumulated by marine organisms to which man may be exposed should be established and maintained.

Predictive Risk Assessment

Regulation of many industrial wastes is based solely upon the results of laboratory biological toxicity assays. We should perform research and development to relate laboratory-derived information to actual effects of economically or ecologically important pollutants in the ocean. This knowledge should be used in predictive risk assessment techniques that are under concurrent development.

OCEAN DUMPING OF DREDGED SPOIL

Dredged spoil of itself is not necessarily a pollutant. It's polluting qualities depend upon the extent to which it has been subjected to deposition of other polluting wastes and, secondarily, upon where it is deposited in the marine environment. Even unpolluted spoil can be a pollutant in areas where marine species are affected adversely by siltation, such as coral communities and oyster beds. Further, the technology of dredging is primitive and the several methods developed which are less primitive are limited geographically to the areas in which specialized dredges are available. Although dredged spoil need not be a pollutant, relatively little and only recent attention has been given to alternative uses, such as wetlands restoration, artificial island construction, artificial wetlands construction, and use in paving and building materials. Clearly harbor dredging must continue for purposes of commerce, national security, and perhaps even public health. Therefore, there is much technological development and use research required to prevent dredged spoil pollution and to turn the spoil to beneficial uses.

Disposal Site Analysis

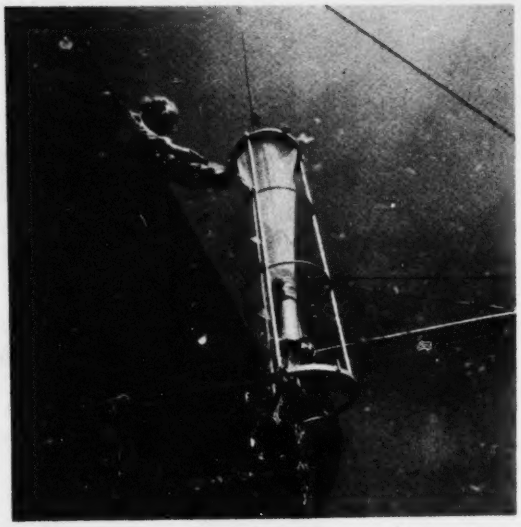
The issue of what circumstances call for containment of spoils and which require their dispersal needs to be resolved. Monitoring of existing and new ocean disposal sites is mandated by 40 CFR, Sections 227 and 228. Data from these monitoring programs should be examined to develop hypotheses and improve predictive methods by which sites for ocean disposal are chosen. Better records should be kept of the quantity and composition of spoils disposed of in the ocean. Monitoring should be conducted so that the persistence of spoil effects may be determined.

Prevention Technology

Means should be developed for dredging with minimal siltation of the water column. These means should also be amenable to cost-effective transport of dredged spoil to land or ocean disposal sites. Different technology may be needed to account for geographical differences in need for improvement and means of disposal. Research and development also should address methods to isolate polluted dredged spoil dumped at sea and at inshore sites from the overlying waters.

Human Health

Thus far no known adverse human health effects have been attributed to polluted dredge spoil in the United States. However, polluted spoil has caused health problems elsewhere in the world. Further, bottom sediments exist in United States estuarine waters which would be hazardous if humans were exposed to them. Thus, in certain restricted areas such as the James River (a saltwater estuary), and parts of the Hudson River estuary where there is heavy bottom pollution by hazardous materials, research and development should address how safely to remove or to isolate pollutants in place and how to dispose of them without endangering workers or the public.



Plankton Net Being Drawn Aboard (EPA, Documerica).

MARINE TRANSPORTATION

SPILL RESPONSE*

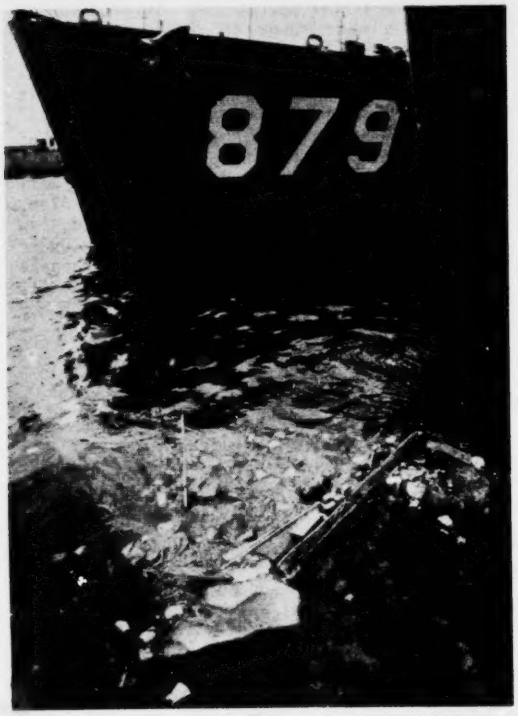
Oil and hazardous material spills range from accidental catastrophic releases to low level leakages of minor importance to the oceans. Industrial and governmental responses to spills have led to the following suggestions for research, development, or monitoring:

Protection of Birds

Water bird populations often are harmed severely by large oil spills. We should refine methods to keep birds from landing in waters affected by acute discharges of oil or hazardous materials.

Identification and Classification of Shoreline Vulnerability

Various shoreline types within a coastal zone are not equally vulnerable to spilled oil or hazardous chemicals. We should identify these differences in vulnerability. Then we should incorporate this knowledge into contingency planning for oil or hazardous material spill response activities. Knowledge of shoreline vulnerability should help to set priorities for deployment of response personnel and materials.



Pollution From Marine Vessels Includes Refuse Dumped in Port and at Sea (EPA, Documerica).

Development of Spill Response Chemicals

Spilled oil penetrates sand causing damage to burrowing invertebrates, and heavier oils coat rocks tenaciously. In these situations, clean-up efforts are as disruptive of ecosystem integrity as is the spill itself. Shoreline damage from these twin causes could be lessened if non-toxic chemicals could be applied to a jeopardized beach to make sands less permeable and oil less adherent to rocks. We should develop such chemicals and perform controlled field testing.

Separating Oil From Water

The effective holding capacity of oil spill storage devices decreases when a lot of water is picked up with the oil. We need to develop a means to separate water from the recovered oil in the device--possibly by means of a non-toxic chemical demulsifier for use within oil recovery devices.

Measurement of Oil Slicks

Oil spilled on the ocean becomes a series of variable patches rather than a single concentrated mass. These patches differ in size and oil concentration, and in their threat to shorelines. We need a means to measure the amount of oil in a given slick so that removal operations may be directed toward greater quantities of oil.

Definition of Harm

For enforcement purposes we must be able to define a harmful quantity of a polluting substance and, secondly, we must be able to measure it easily.

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*Note: It is important to note that many shore based spills are not directly related to marine transportation, but the clean-up technology is similar to that used for spills which result from marine transportation activities.

Shoreline Cleanup Following the Amoco Cadiz Spill Off the Britanny Coast (EPA, Narragansett Environmental Research Laboratory).

Oil Dispersant Effects

In defined situations, Environmental Protection Agency and U.S. Coast Guard can authorize use of chemical dispersants to remove spilled oil from coastal zone surfaces. Continued research should be performed to develop effective chemical dispersants having acceptable health and environmental effects.

MARINE SANITATION DEVICES

Need for Marine Sanitation on Recreational Craft

Devices to hold or treat domestic wastes on small recreational boats must meet minimum requirements set by PL 92-500 et. seq. The need for these regulations has been questioned by the boating industry and boaters based upon both volume and damage to the environment and to human health caused by these wastes. These questions ought to be resolved by federal research.

Chlorination of Small Craft Wastes

Studies should be performed to determine whether chlorinated wastes are more or less harmful than untreated wastes pumped overboard from small craft into coastal and estuarine waters. This is both an environmental and human health issue.

TRANSPORT OF HAZARDOUS MATERIALS

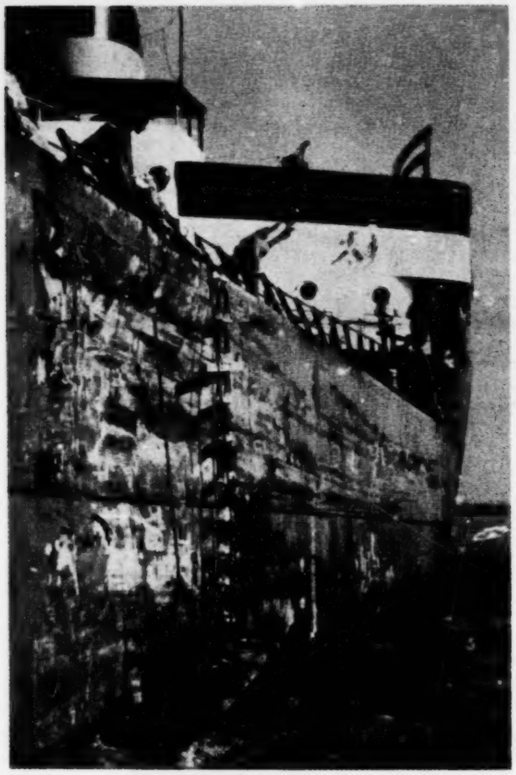
The U.S. Coast Guard identifies cargos of particular hazards in 33 CFR 24-14 (b), and states specific requirements for their traffic control and transfer operations. Information on hazards of a wide range of chemicals is contained in several data storage systems, including USCG's "Chemical Hazards Response Information System", EPA's "Oil and Hazardous Materials Technical Assistance Data System", and "CHEMTEC" run by the Manufacturing Chemists Association. We should obtain better information on general traffic routes for hazardous chemicals as well as trends in quantities transported. Also, continuing research should be performed, in coordination with EPA's responsibilities under the Toxic Substances Control Act, to evaluate the hazards of new chemicals and products. All of these facts are needed for contingency planning and risk evaluations.

NAVIGATIONAL AND OPERATIONAL STANDARDS

Although research in this area is not directly related to ocean pollution, its indirect relationships through vessel accidents are obvious and important. Two areas of need appear promising for the coming five years of research and development to prevent and abate ocean pollution.

Need for Redundant Equipment on Vessels

Considerable technical work and analysis has determined the extent to which placing redundant equipment on vessels may reduce pollution incidents. This topic most recently was discussed at the International Conference on



Oil Spews From Damaged Tanker After Collision With Mississippi River Barge (EPA, Documerica).

Tanker Safety and Pollution Prevention, and is being reviewed within the Coast Guard Commercial Vessel Safety Program. There still is disagreement on the extent to which redundancy should be required. Additional research on relative reliability among various safety systems should prove useful in clearing up the controversy.

Tanker Segregated Ballast

Oil tanker design to reduce pollution due to collisions and groundings is still a subject of contention. The Intergovernmental Maritime Consultative Organization, Society of Naval Architects, Marine Engineers and Ships Structural Committee have been working in this area for some time. Work is needed to determine the best locations for placing segregated ballast to reduce the pollution potential.

OIL TRANSPORTATION

The U.S. Coast Guard needs additional information and capabilities to meet specified congressional mandates on the drafting and enforcement of regulations concerning oil transport. Both new and continuing programs are involved.

Evaluation of Lightering Pollution

The 1978 Port and Tanker Safety Act requires the Coast Guard to regulate offshore lightering operations conducted within the United States outer continental shelf boundary or the economic zone created by the 1978 Fishery Conservation and Management Act. Little information presently is available to define the pollution threat that these operations pose. Sensitivity and statistical analyses of the operation are required to determine this. Such data will allow prudent drafting of required regulations and will support their enforcement.

Development of an Oily Water Discharge Monitor for Vessels

International agreements soon will limit operational oil discharges to 15 parts per million of oil within U.S. waters. The Coast Guard will enforce this agreement. The most efficient enforcement mechanism would require vessels to install an oily water monitor that will indicate and record for Coast Guard review when ballast or bilges were discharged and whether the oil content exceeded 15 PPM. Development of such a device is needed for enforcement.

Emergency Cargo Transfer Systems for Tankers

The need for built-in emergency cargo transfer systems on tank vessels has been investigated by the Intergovernmental Maritime Consultative Organization (IMCO). Efforts to date indicated that such systems would be of limited value. There is still some disagreement about this finding. An additional study to estimate the amount of pollution which would be eliminated if such a system were installed on all tankers, and the estimated cost of placing and maintaining such systems may serve to resolve this matter.

FUEL POLLUTION RISK ASSESSMENT

Identification of Oil Effects

Acute and chronic effects of oil pollution on the environment have been studied for years, and no agreement has been reached by opposing sides concerning their nature or importance. Definitive studies to resolve these issues remain as research needs.

Ocean Hazards of Nuclear Propulsion Vessels

There have been many studies performed to define the risk to the marine environment posed by nuclear propulsion aboard vessels, but their results have caused much disagreement. As fossil fuel supplies diminish large numbers of nuclear propelled vessels may be proposed as an alternative. Risks of ocean pollution effects owing to this change should be analyzed.

Spill Movement Modeling

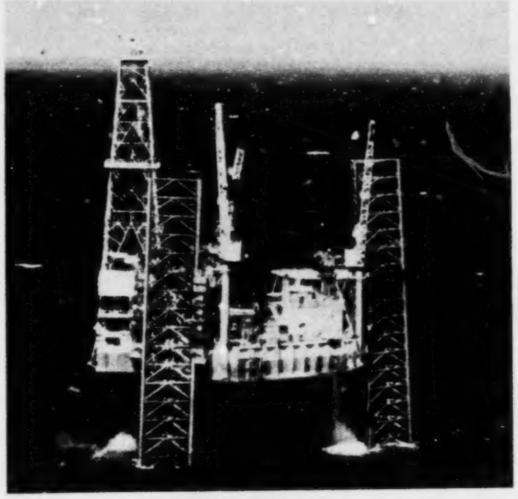
Two dimensional models have been developed to predict pathways that oil and/or hazardous chemicals can follow when released into the marine environment. This work is fundamental to efforts to predict where discharged pollutants will be found within the environment. Three dimensional models which include mixing and toxicity are needed to perform risk analyses and to assist personnel involved in planning clean-up and mitigation strategies during response actions, as well as to assist researchers in predicting distribution of pollutants which will result from planned waste disposal discharges.

The Argo Merchant Oil Spill, 1976 (NOAA).

OCEAN MINERAL RESOURCES

OIL AND GAS DEVELOPMENT ON THE OUTER CONTINENTAL SHELF

Easily extractable U.S. oil is nearly exhausted, and it is increasingly difficult to extract oil on land. This is also true of offshore oil in shallow waters of the Gulf of Mexico. More difficult offshore oil extractions in Alaska and the Northeastern Atlantic and California coast are centers of active industrial interest. Whereas Alaska and California oil fields are proven, Atlantic oil formations are just opening up to exploration and development. Domestic oil and gas supplies take on greater importance as assured oil imports become more subject to international political and economic pressures. Lease sales for OCS oil and gas development continue to be scheduled. Even so, the public call for environmental quality echos loudly through the coastal states, particularly those states which are unaccustomed to oil drilling operations. Thus, it is in Alaska, New York, and the New England States where the balance between finite oil supplies and infinite fisheries and coastal recreation is a matter of heated controversy and even litigation. If we are to preserve our resources as we extract finite fuels and minerals, research and development and monitoring need to provide us better foundations for rational decisions including leasing decisions on how to minimize risks and improve extraction methods.



Offshore Oil Drilling Platform (DOE).

Predicting Drill Platform Blow-out and Spill Effects

Unlike catastrophic tanker spills, those of drilling platforms occur at known places and in known ranges of ocean tidal, current, wave, and wind conditions. Platforms really are "point sources" of potential spills. As such, spills trajectories emanating from a platform can be predicted from rather solid information. Techniques for making these predictions should be improved. For any exploratory platform in place, seasonal winds, currents, waves, geological hazards, and living marine resources are known, as is the type of oil produced and its toxicity and persistence as a toxicant.
Before production platforms are constructed, these data should be incorporated into a risk analysis to determine whether or not and how production facilities should be built.

Oil Spill Damage Assessment

The 1978 Outer Continental Shelf Lands Act Amendments establish an oil spill compensation fund managed by the U.S. Coast Guard which authorizes reimbursement for losses to national resources. A similar compensation fund may be established soon to compensate for losses of natural resources due to discharges of oil and hazardous chemicals from other sources. Questions that need answers in every instance are: what was damaged?; how was it damaged?; and how much was it damaged? What we need to know is how to convert losses of natural resources into equitable monetary values. A major research effort is recommended to develop this method.

Oiled Shallow Water Fisheries

Highly productive, shallow water fisheries such as Georges' Bank are particularly susceptible to damage by effluents and catastrophic spills from production platforms. Fisheries managers are capable of predicting the effects of fishing pressure on subsequent fish harvest with an accuracy approximating 20 percent. These methods, used for the International Commission on North Atlantic Fisheries deliberations, should serve as a springboard for predictive risk assessment of oil effects, given toxicities, oceanic trajectory and mixing conditions, and the several seasonal resources at risk. The two worst possible cases and most likely case production accidents should at least be assessed bimonthly.

Blow Out Prevention

We should develop improved well control procedures and blow out prevention equipment for

Skipjack Tuna School (NOAA).

deep water drilling. These should be tested and put to use as quickly as possible.

Platform Oil Spill Containment and Clean-Up Equipment

Present oil spill containment and clean-up devices work only in the mildest offshore sea conditions and are not suitable to contain rough water spills. More effective containment and oil recovery devices could reduce ecological and economic losses. Their development should be undertaken in collaboration with industry.

Special Needs for Arctic Oil and Gas Production

- We know little about how spilled oil travels under ice or about its effects there. Of particular concern are oil accumulations in leads and brine ponds and their effects on migrating marine mammals and birds. Studies of these matters are recommended.
- Although means to cap blowouts under ice are necessary due to rapid movements of the winter ice pack, the technology for blowout prevention and stoppage under ice is at present speculative and should be developed.
- The arctic undersea ecosystem is not well understood under normal conditions. Variations in its structure and function need to be measured as baseline information. Effects of spilled oil on arctic ecosystems, and ecosystems' recovery from spilled oil should be determined experimentally and, as opportunities arise, in the field.

A Colony of Fur Seal Bulls, Cows, and Pups, Pribilof Island, Alaska (NOAA).

Identification of Marine Resources

In order to make better decisions relating to OCS leasing, the resources in lease tract areas (including fish, birds, mammals and their habitats) should be identified. Measures which could be taken to avoid or minimize danger to the resources in these areas should also be determined.

Exploratory and Development Drilling

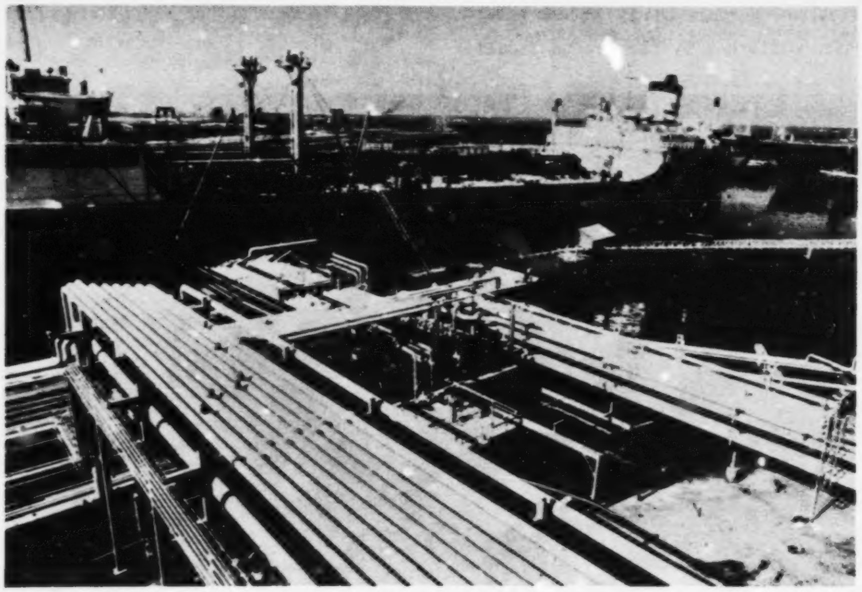
- Normal operational discharges from exploratory and production rigs at sea are comprised largely of drilling muds, drill cuttings and brines. While we have some information about their ecological effects on Gulf and California coastal under-sea life, almost nothing is known about their effects upon the ecosystems of Georges' Bank, the Mid--Atlantic, and Arctic lease sale areas. A comparison of geological hazards among these areas is recommended. Laboratory and field studies of ecological effects of drilling are recommended particularly for sensitive marine life such as coral, fish and shellfish spawning and nursery areas, and for bottom communities in the vicinity of drilling platforms.
- Drilling muds vary in chemical composition to fit differing needs of the drilling process. Their range of composition should be examined for amounts of components harmful to marine life. Based on this information, protocols should be established for use and disposal of potentially harmful drilling muds in areas where their overboard discharge would either be deleterious or imprudent.
- A variety of overboard discharge methods for operational drilling platform wastes should be investigated. Suggested investigations are shunting to various depths, storage and transport from site, onsite reconditioning or cleaning of drilling muds, and onshore disposal.

Production, Collection and Transportation

Production, collection, and pipeline transport of offshore oil and gas are, at least in part, siting issues. Whether drilling facilities are a hazard to marine biota or a sanctuary for them remains to be resolved. Risks due to spills should be compared with risks due to fishing and over-fishing, as well as with risks of additive worst case situations involving both. Geological hazards to pipelines and hazards of pipeline construction to marine life and the biota of on-shore wetlands and barrier beach portions of the pipeline should be considered. Analyses should include consideration of real hazards to pipeline integrity caused by geologic instability (faults, sediments, sand waves), excessive permafrost, ice gouging, and undersea activities of man.

DEEP SEABED MINING

Admitting that jurisdictions are at best unclear, and at worst, matters of serious international disagreement, we have considered pollution of the deep sea floor a common concern to all. A primary national need is resolution of the jurisdictional question. To the extent that



Tanker Port Unloading Facility (DOE).

this is likely to occur in the next five years, the following needs for research, development and monitoring are pressing.

Surface and Water Column Effects

Bringing deep ocean water turbid with sea floor sediments to the surface may not necessarily cause significant pollution in the water column. Although the objective of mining is to bring only mineral nodules to the surface, with present technology it is impossible to avoid raising some bottom sediments along with the minerals. The following research on surface waters is recommended:

- Characterize the particle size range of particulate discharges, their chemical composition, and their physical integrity.
- Determine the distribution and fate of sediments discharged at the surface.
- Examine the extent to which surface discharges stimulate or inhibit plankton populations and whether or not dissolved or particulate discharged material enters the marine food web.
- Consider the necessity and practicality of discharge below the thermocline and pycnocline.

Bottom Effects

In essence, deep sea mineral extraction strip mines the surface of the sea floor and is by necessity highly disruptive. However, at any given time, it causes a small, single traveling point of disruption. We need to know whether this disruption affects deep sea life. Further, we should find out the extent to which deep sea living creatures are important to man. Toward these, the following research is recommended:

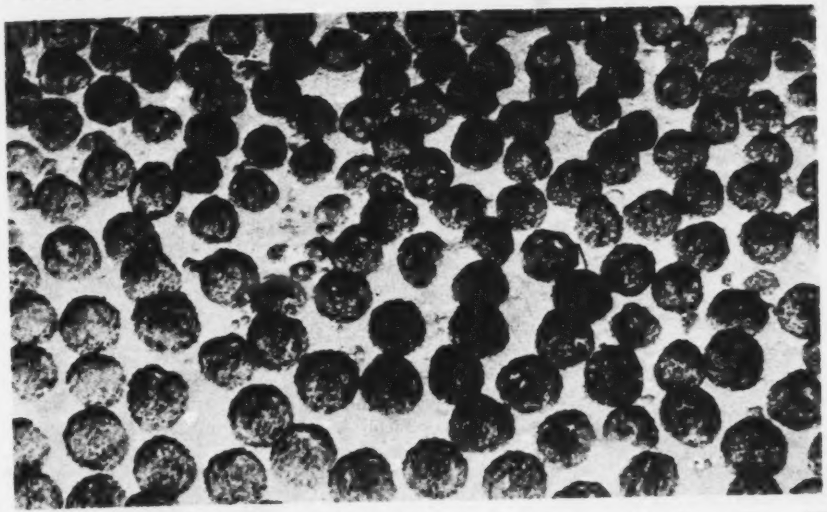
- Species disturbed by the dredge should be inventoried.
- Effect of the mining process on deep sea life should be described (e.g., masceration, siltation of habitats or food organisms, attraction and destruction, avoidances, etc.).
- The possibility of recolonizing disrupted areas should be investigated.
- The prospect of regrowing mineral deposits should be investigated.

Processing and Production

In theory, the least environmentally disruptive mining technology should be the most efficient industrial process. The development of deep sea mining methods should therefore proceed toward this goal. Chemical and physical properties of any process wastes discharged at sea should be analyzed and investigated for polluting properties, and the fate of these wastes at sea should be determined.

SAND, GRAVEL, AND SHELL MINING

Onshore sand, gravel, and shell mining pose a much greater immediate threat to living resources than deep sea mining. Onshore mining occurs on the shallow continental shelf, in areas teeming with ecologically and economically important marine life and represents a use which competes with ecological habitat stability, sport fishing, commercial fin and shell fishing, navigation, and aesthetics of the coastal zone. Although it does not introduce foreign matter and chemicals into the sea, its effects are related to extreme disruption of the shallow sea floor--excavation and consequent siltation. Some information on these effects is available as spill-over from channel dredging projects, but it is not specific to mining activities, which differ somewhat from dredging in technology, practice, and location. The following research is recommended:



Manganese Nodules, A Few Inches in Diameter, Rest on Pacific Ocean Floor (NOAA).

Shell Dredging Operation (EPA, Documerica).

Technology Development

Mining technology that is less disruptive to the water column and surrounding seafloor should be developed. Silt containment and pattern mining to match hydrologic features of the area should be considered.

Long Term Effects

Long-term effects of sediment from mining waste on fishes and bottom dwelling species should be established for consideration in permitting processes.

Sediment Hazards

Short-term effects on the metabolism and survival of organisms confronted with high concentrations of suspended fine sediments in the vicinity of mining activities should be determined.

Bottom Disruption

Effects of mining excavations in the sea floor on marine plants and animals should be described and evaluated.

Onshore Effects

Onshore delivery of mined product for subsequent processing and utilization should be evaluated for ocean polluting effects.

Planning Studies

Demographic, socio-economic, and environmental effects of the development and maturation of the sand, gravel, and shell mining industries should be investigated and results made available for coastal zone planning.

BRINE PRODUCING ACTIVITIES

Natural and man made brines put in the ocean are heavier than seawater and so tend to creep along the bottom in streams until physical mixing disperses them. In the few places where this is a problem, effects can be devastating to exposed marine life. Thus far, the problem has been rare, highly localized, and a threat only to marine life in the vicinity.

Brine producing activities are desalination for production of fresh water and the storage of gas in underground or undersea salt domes. Alternative technologies and safety precautions for salt residue disposal should be developed on a case-by-case basis. Criteria for imposing these treatment technologies should be founded upon ecological and economic considerations.

At Depths Where Nodule Mining Would Take Place, The Diversity And Abundance of Lifeforms Revealed by Special Cameras is Considerably Greater Than Had Previously Been Thought to Exist (DOE).

LIVING OCEAN RESOURCES

Industries that farm or process living marine resources may pollute the ocean with their facilities and their wastes. Shellfish and finfish harvesting industry wastes become processing wastes onshore. Harvesting effects on living marine resources result less from pollution than from overfishing the resource itself. Except for certain declining fish or shellfish populations which are more vulnerable to other pollutant effects than are large and healthy populations, fishing effects per se are outside the scope of an ocean pollution study plan. Ocean pollution aspects of offshore fishery resource management should become a more prominent subject of future PL 95-273 plans as small but concentrated fisheries such as Georges Bank come into conflict with other offshore ocean uses having great pollution potential, such as oil production. For the duration of this study plan, a low to moderate effort to fulfill the following needs is suggested:

Fish and Shellfish Processing Wastes

The present and projected pollutant loading of U.S. coastal waters from fish and shellfish processing is not known. We should have this data to make economic and ecological choices. Also, the kinds of pollutant problems caused by suspended and dissolved solids, turbidity, pH changes, oxygen demand and oil and grease in these wastes should be documented and evaluated for ecological significance. The extent to which these wastes are siting or treatment problems should be examined.

Hatchery and Aquaculture Wastes

Hatchery and saltwater aquaculture facilities are highly individual and their polluting characteristics are largely related to site suitability. Most such facilities operate with no reported problems. Estimates of industry increases and characteristics of problem facilities should be attempted to determine whether or not farming the oceans will become a pollution or siting problem in the forseeable future.

Tuna Cannery (NOAA).

Examination of Flounder For Pathology Associated With Pollutants (EPA, Narragansett Environmental Research Laboratory).

OCEAN RECREATION

Pollution caused by recreational activities is relatively small in amount. Most forms of recreation related pollution are subsets of problems relating to marine waste disposal and marine transportation. These will be mitigated by specific solutions to those problems. Two categorical problems deserve special treatment.

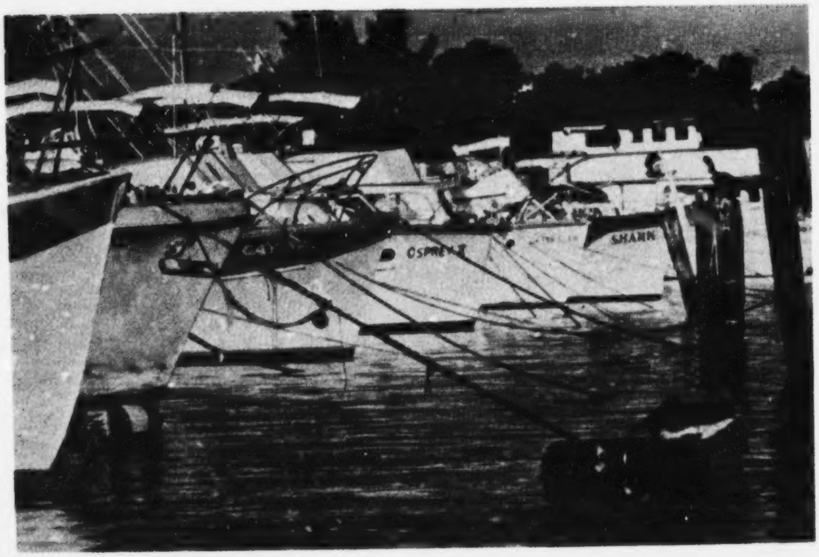
Marine Litter

Although 103,000 tons of litter per year strewn upon U.S. coastlines is miniscule compared to solid waste problems of even a small municipality, we do not know much about its effects in coastal waters. The kind and importance of these effects should be investigated to determine what, if anything, need be done.

Habitat Disruption

Scallop dredging, spearfishing, and coral harvesting are disruptive to the habitats of animals other than those which are sought. These activities have vested, highly vocal proponents and opponents who make conflicting claims about their activities' adverse effects. Objective assessments of their hazards to the ecosystem, real extent, costs, and benefits are needed to make intelligent choices at the state and federal regulatory level.

Smelt Fishermen Cast Nets in Northern California Surf (EPA, Documerica).


OSPREY II
SHARK

Pelican on Mooring at Florida Marina (EPA, Documerica).

LAND USE PRACTICES CAUSING OCEAN POLLUTION

There are no federal land use laws or regulations because the states, when forming the federation, kept such powers to themselves. Only in land use matters involving interstate commerce or national defense may the federal government pre-empt state authorities. Thus the Coastal Zone Management Act and PL 92-500's section 208 required planning for waste disposal depend upon voluntary compliance by state governments. Nevertheless, the coastal zone is a continuous, thin band abounding in rich marine life which varies with geographic and hydrographic features rather than with state lines. Migratory fishes seem to scoff at man's boundaries, and for pressing physiological reasons many northern species refuse to populate the sunbelt. Further, state governments vary widely in their concepts of the best and wisest uses of the coastal zone; tourism vs. developments, fisheries vs. oil production, marine parks and sanctuaries vs. commerce, refineries vs. recreation; all are argued differently among the coastal states. The resolution of this jurisdictional problem is well outside the scope of this plan. National needs and problems are discussed here as they relate to onshore land use practices which pollute the oceans, regardless of who will use research, development, and monitoring information to solve these problems.

Habitat Modifications

Man's alterations in coastal environments cause the most insidious and long-lasting damage to ecosystems. Filling and dredging may allow man's use of the environment while having unplanned consequences to natural uses.

Effects often extend beyond the predicted sphere of impact and can be felt over a long period of time. Alterations may be temporary with natural environmental patterns quickly reestablished through compensatory processes or they may be permanent. We need to know the pervasiveness of physical alterations in coastal and estuarine environments, because such alterations can affect wetland and estuarine productivity.

- Effects of dredging and channelization on selected estuarine and coastal ecosystems should be determined.
- Effects of altered hydrologic regimes on salinity, temperature, and nutrient regimes in selected coastal bays and

Development of Artificial Reefs, Marco Island, Florida (EPA, Documerica).

estuaries where such modifications have occurred should be investigated. Potential changes in relatively unaltered regimes should be predicted from results of these investigations.

- Effects of altered sedimentation patterns due to increasing turbidity, spoil disposal, channelization, dredging and resource extraction on selected estuarine ecosystems should be measured.
- Effects of reductions in aquatic vegetation (marshes, swamps, mangroves, seagrasses and macroalgae) on coastal marine ecosystems should be studied.
- Effects of wetland losses due to filling and grading should be measured.
- Habitat areas critical for certain species should be identified and ecosystem implications of loss or physical modification of such areas should be defined.

Non-point Source Pollution

- A comprehensive inventory of pollution entering the coastal oceans from non-point sources should be compiled on a regional basis and updated frequently. The inventory should focus on selected critical pollutants from both riverine and air sources.
- Existing levels of selected critical pollutants in estuarine, coastal and offshore waters should be determined by regularly scheduled monitoring. General models of flow into and through the narrow coastal region (wetlands out to 3 miles offshore) should be developed and verified. These regional loading models can be factored into point-source discharge permit conditions.

Facility Siting

Each industrial facility sited along the shoreline has its own set of requirements for transportation, transmission, fresh water, salt water, power, communications, labor force and markets. Any of these matters may prove critical in its absence. Often, environmental considerations come late in industrial siting protocols--so late, in fact, that environmental protection is considered a backfitting procedure by many industries which own environmentally unacceptable or marginally acceptable sites. This can be very costly, not only to the industry but to environmentalists and governmental regulators. In the final analysis, these costs are borne by consumers and taxpayers.

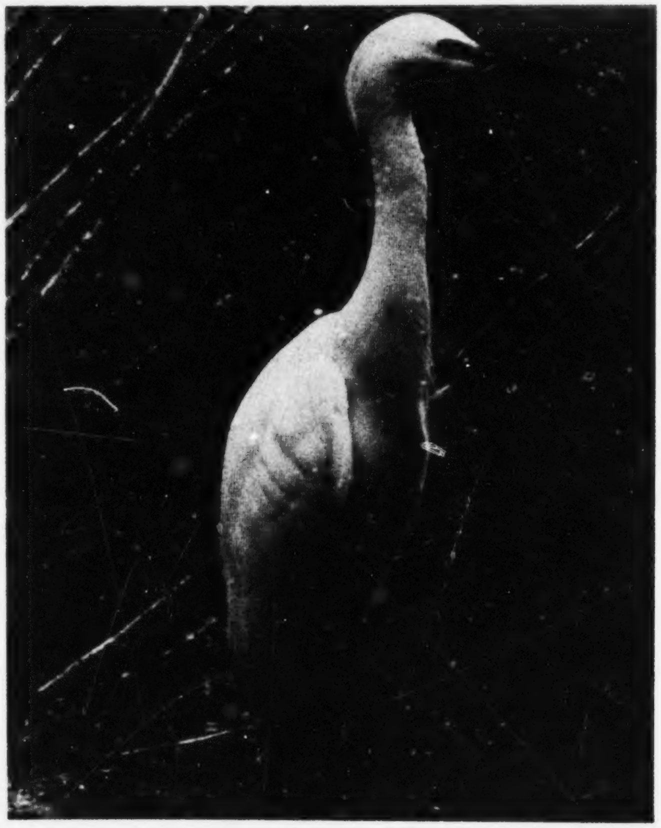
There are needs for siting information as such, and there are needs to revise and streamline siting procedures and protocols. Environmental siting criteria are known and understood by regulators and the industry, but should be codified and agreed upon to the extent possible.

Shoreline Erosion Stemming From Development in Georgia (EPA, Documerica).

Further needs for information may emerge from this process to become subjects of research, development, or monitoring. Procedural and protocol siting needs largely are institutional, and as such are outside the scope of ocean pollution study. However, available studies, experiences, and experts should be included in the process of institutional change if and when it occurs.

Aesthetic Considerations

Ocean pollution is not aesthetic, nor are many of its causes. It generally is agreed that "quality of life" in the coastal zone cannot be measured in purely economic terms. Contemplative values of contact with the unaltered coastal zone have few *ad hoc* advocates, until the zone is altered and the option for exercising those values is gone. We need to know how much remaining coastal zone there is that the public perceives as still aesthetically pleasing.



The Snowy Egret is a Bird of Coastal Marshes. (V. DiPasquale, SCS Engineers).

Report of the Subcommittee on

Ocean Pollution Data Collection, Storage, and Distribution

Working Paper 3
April 1979

H. William Menard
Subcommittee Chairman

Submitted in compliance with Section 8 of the National Ocean Pollution Research and Development and Monitoring Planning Act of 1978 (Public Law 95-273)

Interagency Committee on Ocean Pollution Research, Development, and Monitoring

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Federal Coordinating Council for Science, Engineering, and Technology

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EXECUTIVE SUMMARY

It has been recognized that there is a great and increasing need for data and information regarding ocean pollution and its associated problems. The need for adequate data and information services to support ocean pollution research and development and monitoring activities conducted by Federal agencies is especially acute.

The Subcommittee on Ocean Pollution Data Collection, Storage, and Distribution examined the current state of ocean pollution data and information services within the Federal structure, concentrating on the present Federal capability to provide these services and on the relationships of the Federal agencies involved.

The Subcommittee's basic recommendation is to establish an Ocean Pollution Data and Information Network comprised of three components:

- Subject Area Data/Information Centers;
- A Depository; and
- A Central Coordination and Referral Office.

Following the mandate of Public Law 95-273, this proposed Network will use existing facilities to the greatest extent possible.

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REPORT BY SUBCOMMITTEE ON DATA COLLECTION, STORAGE, AND DISTRIBUTION

I. OCEAN POLLUTION DATA AND INFORMATION NEEDS

A. The Need Defined

The need for better information and specific data to effectively address the problems of increasing ocean use and ocean pollution is well known. This need is becoming greater as ocean-related activity and coastal development increase. It also is reflected by the growing number of requests for ocean pollution data by policy makers, environmental managers, and special interest groups. A complicating factor is the complexity of the national ocean effort, which is fragmented at the Federal level among 8 departments, involving 37 agencies, and 9 independent agencies. Perhaps it is this size and complexity of the Federal ocean effort that contributes to another vexing problem -- the ineffective and inefficient use of available data and information resources.

B. Mandate to Confront the Problems

Public Law 95-273, the "National Ocean Pollution Research and Development and Monitoring and Planning Act of 1978" requires that the Administrator of the National Oceanic and Atmospheric Administration (who is responsible for preparing and carrying out a comprehensive 5-year Federal plan in ocean pollution research and development and monitoring), and the heads of other Federal agencies, keep abreast of all developments relating to ocean pollution and use of coastal and ocean resources. The Act further states that activities supported by it be carried out whenever possible through existing Federal programs and agencies.

C. The Subcommittee's Approach

Section 8 of the Act directs that the Administrator of NOAA "shall ensure that the results, findings, and information regarding ocean pollution programs conducted or sponsored by the Federal Government be disseminated in a timely manner, and useful forms" to all interested parties. The tasks of the Subcommittee on Data Collection, Storage, and Distribution derive primarily from Section 8. The Subcommittee has been charged to: describe the Federal capability to collect, store, and distribute data and information generated by ocean pollution research and development and monitoring programs; assess the adequacy of this capability; and recommend ways to improve the Federal capability.

Section 8 of the Act requires that the Subcommittee consider systems for handling different kinds of ocean pollution data and information, specifically "results, findings, and information regarding ocean pollution research and development and monitoring programs." During its work, the

Subcommittee tried to keep this broad scope in mind, and tried to distinguish among different types of ocean pollution data and information systems.

The Subcommittee also addressed the question of considering systems that are not related to ocean pollution, but possess desirable features that could be adapted to handling ocean pollution data and information. It was decided that although some nonoceanic-related systems might well serve to handle ocean pollution data, a detailed discussion of such systems would be cumbersome and unproductive and could divert the Subcommittee from its primary task.

D. Rationale for the Report

The Subcommittee decided the primary emphasis of its inquiry should relate to the current Federal effort to collect, store, and distribute environmental, and specifically marine pollution, data and information. Members of the Subcommittee served as primary points of contact for assessing and describing available ocean pollution data and information systems within their own agencies. These comprise section II of this report.

The report not only includes descriptions of systems that handle environmental data resulting from marine pollution research and development and monitoring activities, but also published findings of these programs. Another kind of system considered by the Subcommittee is a system for handling programmatic data — data about ocean pollution programs, such as fiscal and other management information. The Subcommittee considers such a system an important aspect of effective overall management of the Federal ocean pollution research and development and monitoring program. Although planning for such a system is not complete, there is agreement that a centralized source providing this type of information is needed to inform agencies of ongoing and planned marine pollution programs. Further, such a system should be the primary supporting mechanism for the collection, storage, and manipulation of information used to prepare the biennial revision of the comprehensive Federal plan mandated by the Act. The planning done to date on this system still needs refinement; more definitive plans for its design and implementation need to be developed.

E. Organization of the Effort

Subcommittee members performed their assigned tasks while carrying out their normal work activities. Because of these limitations, and the time limitations of securing information about and assessing all available systems in various Federal agencies, some descriptions in section II should be considered cursory. Sections III and IV are based on section II and must be considered accordingly. In developing and carrying out the Federal plan, it is recommended that specific personnel, perhaps a task group, be assigned full-time responsibility to ensure that the capabilities of data and information systems be used most effectively and that planning and system design are complete.

II. REVIEW OF DATA AND INFORMATION SYSTEMS AND PROGRAMS

A. Categories of Systems

During the subcommittee's deliberations and review of existing systems for handling ocean pollution and related marine environmental data and information, a wide variety of systems and designs were considered. These perform a number of special functions. To bring some order and clarity to this vast amount of detail, these systems were related to a few well-defined types of systems. Most, if not all, of the described systems can be classified as, or contain elements of, one of the following categories of systems:

- "Hard" data -- contains alphanumeric records of actual measurements or observations.
- Data referral -- indexes or inventories data collections and contains only descriptions of data files.
- Bibliographic information -- contains citations to books, journal articles, technical reports, and other publications.
- Document distribution -- disseminates copies of technical reports and other publications.
- Management information -- contains information about scientific projects -- project name, sponsoring organization, name(s) of principal investigator, source of funding, and personnel information.

These are the kinds of systems required to handle the various types of data and information generated by, or derived from, research and development projects. They are typical of systems described in the following sections, and those which must be incorporated into any comprehensive ocean pollution data and information system.

B. Survey by Department or Agency

1. U.S. DEPARTMENT OF AGRICULTURE

The Department of Agriculture (USDA) has several computer-based data and information services that can be used in the Federal ocean pollution program. The DOA components providing these services are the Science and Education Administration (SEA) and Economics, Statistics, and Cooperative Service (ESCS). SEA computer-based information services support bibliographic, project management, and personal information systems. ESCS (formerly the Economic Research Service and Statistical Reporting Service) handles large volumes of agricultural data. It collects data for the domestic agricultural economy and documents agriculture-related information, both domestic and international.

Agricultural research includes a vast amount of scientific and technological data and information ranging from basic research in chemistry and biology to applied research in waste management and marketing economics. In general, these data and information collecting activities are extensive, and are supported by numerous cooperating State and local organizations. Various computerized data and information systems are used to store, retrieve, interpret, and disseminate this data and information to agricultural users.

SEA and ESCS data services are available to all USDA personnel and their cooperators. Available systems include the Current Research Information System (CRIS), a project documentation and reporting system, the AGRICultural On Line Access (AGRICOLA), a publication citation (bibliographic) system, and others. These systems and ESCS's System 2000 Data Base Management System are indicative of the type of systems used for hard data. SEA also provides personalized information files through a software system called FAMULUS.

CRIS, the research project documentation and reporting system, provides ready access to information about the research activities of the DOA, the State Agricultural Experiment Stations, and other cooperating institutions. The basic unit of documentation and reporting is the Research Work Unit, a research activity at a single location that focuses on a clearly-defined problem, a sizable part of a very big problem, or a few closely related elements of interest that together form a logical and manageable package. Data elements documented in the system include project identification information, performing organization, location, responsible organization, investigator(s), start date, termination date, title, objectives, approach, annual progress, publications, expenditures, and man-years of effort. CRIS is available on-line and currently contains about 29,000 citations. Varying levels of access are provided to different users so that sensitive information is available only to authorized persons. Full Boolean logic is available for information retrieval. A search for ocean-pollution-related projects retrieved 258 citations.

ESCS uses the System 2000 Data Base Management System (DBMS) for handling and interpreting agricultural and related economic data. Files include statistics on crops, livestock, poultry, dairy prices, and labor. These files and the interpretative analysis of these data are part of several large cooperative agricultural data networks such as the Crop Reporting Service Network.

AGRICOLA is a family of bibliographic data bases covering general agriculture, food and nutrition, and agricultural economics. Because it contains the actual holdings of the National Agricultural Library, there is substantial coverage of all subject matter normally held in a very large library. The SEA Technical Information Services's Agricultural Information Division creates and maintains this data base, using the System for the Automated MANagement of Text for a Hierarchical Arrangement (SAMANTHA) software. A search of AGRICOLA produced a listing of 617 ocean pollution-related publications. The SEA ADP support group also maintains the machine readable bibliographic files which are used in the Current

Awareness Literature Service (CALS) and the personalized citation files created and maintained for individual agricultural scientists in DOA by the FAMULUS software. Although these files do not hold much information directly concerning ocean pollution, a few -- such as the Pesticide Residue File -- contain related and supporting information.

2. U.S. DEPARTMENT OF COMMERCE

Two major components of the Department of Commerce (DOC) provide data and information services -- the National Oceanic and Atmospheric Administration (NOAA) and the National Technical Information Service (NTIS).

a. National Oceanic and Atmospheric Administration

NOAA was established in 1970 as the primary Federal focus of nondefense oceanic and atmospheric research, development, and services. NOAA's headquarters are in Rockville, Md. Its offices and facilities are scattered throughout the Nation. The five major components are the Office of Fisheries, the Office of Coastal Zone Management, the Office of Research and Development, the Office of Oceanic and Atmospheric Services, and the Office of Administration.

The Office of Oceanic and Atmospheric Services has charged the Environmental Data and Information Service (EDIS) to:

> "Acquire and disseminate global environmental data (marine, atmospheric, solid-earth, and solar-terrestrial) and information tailored to meet the needs of users in commerce, industry, agriculture, the scientific and engineering community, the general public, and Federal, State, and local governments; provide experiment design, data management, and analysis support to national and international environmental programs; assess the impact of environmental fluctuations on food and energy, environmental quality, and telecommunications; manage and/or provide functional guidance for NOAA's scientific and technical publication and library activities; operate a network of specialized service centers, a field liaison service, and a comprehensive data and information referral service; and operate related World Data Center A facilities and participate in other international data and information exchange programs."

EDIS includes the Office of the Director, in Washington, D.C., and five service centers: the National Oceanographic Data Center (NODC), Washington, D.C.; the National Geophysical and Solar-Terrestrial Data Center (NGSDC), Boulder, Colo.; the National Climatic Center (NCC), Asheville, N.C.; the Environmental Science Information Center (ESIC), Rockville, Md.; and the Center for Environmental Assessment Services (CEAS), Washington, D.C.

NODC, NGSDC, and NCC perform similar functions for specific kinds of environmental data. They collect, process, store, and disseminate oceanographic, geophysical, and climate data, respectively. ESIC is NOAA's information manager and librarian. It deals primarily with the printed word. CEAS provides expertise in experiment design and the analysis and interpretation of environmental data. Although the centers have common features, each provides unique capabilities for handling specific marine environmental data and information.

i. National Oceanographic Data Center

The National Oceanographic Data Center (NODC) is the national repository for data on the physical, chemical, and biological properties of the world ocean. NODC's primary data systems are its oceanographic and marine environmental data bases and their associated data inventory, retrieval, and product-generating software. Besides observations of temperature, salinity, nutrient chemistry, surface and subsurface currents, primary productivity, and other "standard" oceanographic data, NODC is collecting and disseminating a broad spectrum of multidisciplinary marine environmental data ranging from trace metal concentrations to observations of marine birds and mammals. It holds data from programs and projects concerned both with fundamental ocean properties and processes and with marine environmental baseline and ocean pollution studies.

NODC provides data base management, project management, data product development, and related supporting services to marine environmental assessment studies and marine pollution monitoring projects of national and international scope. The largest U.S. projects from which NODC receives, processes, and disseminates environmental data are NOAA's Marine Ecosystems Analysis (MESA) Program and the Outer Continental Shelf Environmental Assessment Program (OCSEAP), which is conducted jointly by NOAA and the Department of Interior's Bureau of Land Management (BLM). The MESA studies have focussed on three areas: the New York Bight, Puget Sound, and the Deep Ocean Mining Environmental Study (DOMES) area in the central Pacific where manganese nodules on the sea floor are of interest. Work is scheduled in Alaska's Prince William Sound. Because development of new petroleum resources and facilities is further advanced on the Alaskan continental shelf than in proposed lease areas off the "lower 48," most of the BLM Environmental Studies Program effort has been concentrated on the Alaskan Continental Shelf. Work with BLM also is underway in the Mid-Atlantic, South Atlantic, south Texas, southern California, and other OCS areas.

On the international level NODC receives and processes data collected under the auspices of two major pollution-related projects, the Environmental Quality Program of the International Decade of Ocean Exploration (IDOE) and the Marine Pollution Monitoring Pilot Project (MAPMOPP). The latter was organized by the UN Intergovernmental Oceanographic Commission (IOC) and World Meteorological Organization (WMO) within the Integrated Global Ocean Station System (IGOSS). The IDOE Environmental Quality Program data accessioned by NODC is primarily physical and chemical baseline study data that scientists can use to study mixing and transport processes and their effects on the movement and dispersion of manmade pollutants in the oceans.

The IGOSS/MAPMOPP data consist of actual observations and analyses of a specific pollutant -- petroleum. Petroleum was selected as the test substance because it is a major pollutant and because it can be monitored by nations possessing widely varying degrees of expertise. This Pilot Project originally was scheduled to terminate the end of 1976, but was extended through 1978.

Much recent effort at NODC has been devoted to developing computer-generated data products and marine environmental data formats. Data products now available include a wide variety of data listings and analyses, and graphic data displays such as vertical section plots and horizontal contour plots. Multidisciplinary data are recorded and archived in over 50 specially designed digital data formats, or "file types." Many of the file types contain data directly or indirectly related to pollution studies. Some contain direct pollution measurements and pollution baseline data. Examples are: metals in organisms, sediments, and water; trace metals; light hydrocarbons; and heavy hydrocarbons.

One of the best examples of the application of these capabilities is the NODC Catalog of OCSEAP Data, the first two parts of which have been given an initial limited printing and have been distributed to OCSEAP scientists. Part I, Distribution of Digital Data, contains computer plots showing the locations and numbers of observations of different kinds of data collected in and around the nine proposed oil lease areas. Part II, Inventory of Digital Data by Lease Area, is a detailed list of information about individual data sets. Parts III and IV, scheduled for future publications, will contain digital data formats and examples of data summaries and graphic plots.

To assist in the overall management and coordination of complex data collection efforts, such as OCSEAP, NODC developed a Data Tracking System. This system allows NODC to monitor each subtask and helps ensure the smooth flow of data from the field to the NODC archives. Online inventory systems are available to inform users about available data. NODC is designing a new system to handle multidisciplinary data -- so that this data can be archived and retrieved as efficiently as standard oceanographic data.

In support of EDIS's user referral service, NODC maintains the Environmental Data Index (ENDEX), a set of computer-searchable data bases containing descriptions of environmental data collections held by Federal, State, and local agencies, academic and research institutions, and by private organizations throughout the country. ENDEX data bases include the following:

- Environmental Data Base Directory (EDBD), which contains descriptions of over 12,000 environmental data files held by agencies and institutions in the United States.
- Bottom Photograph Camera Station File (Photo), which contains descriptions of bottom photos taken at over 7,500 stations.

- NODC Index for Instrument-Measured Subsurface Current Observations (NIMSCO), which describes files of current meter data.
- Report of Observations/Samples Collected by Oceanographic Programs (ROSCOP), which is an automated file of the ROSCOP form recommended for use by the Intergovernmental Oceanographic Commission as a means for providing timely information about oceanographic projects collecting data not yet archived and available from one of the World Data Centers or National Data Centers.

Each year NODC provides thousands of users -- both technical and non-technical -- with data, data products, publications, bibliographic search and data referral services, and general marine science information.

ii. National Geophysical and Solar-Terrestrial Data Center

The National Geophysical and Solar-Terrestrial Data Center (NGSDC) is responsible for handling data in solid-earth geophysics (e.g. seismology, gravity, marine geology and geophysics) and solar-terrestrial physics, the study of the influences on the Earth of the sun, solar activity, and the interplanetary medium. NGSDC manages an extensive archive of marine geological and geophysical data for the deep ocean and coastal areas of the United States. Contained in this data bank are large quantities of seismic data, tsunami data, geological data, underway geophysics data (marine magnetic, gravimetric, and other data taken from a vessel steaming along a predetermined trackline), high-resolution bathymetric data, and other data pertaining to geological hazards.

NGSDC's marine environmental data-handling capability supports ocean pollution research and development and monitoring activities in three principal ways: (1) by establishing baseline geological and geophysical conditions from which to determine pollution induced environmental changes, (2) by providing data that aid in the exploration and development of off-shore oil and gas deposits, and (3) by indicating geological hazards that could affect oil and gas recovery and the siting of offshore facilities.

NGSDC has data exchange agreements with all major U.S. institutions and governmental agencies that collect and use marine data. It acquires, stores, and disseminates marine geology and geophysics data from many of the same projects for which NODC handles oceanographic data — including IDOE, OCSEAP, MESA, and DOMES -- and maintains automated data monitoring and tracking systems that can describe the availability of data.

NGSDC has access to sophisticated computer hardware, software, data copying systems, and other data storage and processing devices. It disseminates a broad spectrum of data products ranging from direct copying of digital and analog data to specialized data products, such as plots, summaries, or compilations.

iii. National Climatic Center

The National Climatic Center (NCC) is the collection center and custodian of all U.S. weather records. NCC obtains the data generated by NOAA's National Weather Service, the weather services of the Air Force and Navy, and the Federal Aviation Administration, Coast Guard, and cooperative observers on land, at sea, and in the air. It also archives cloud photographs and other data obtained from environmental satellites.

NCC's holdings include a global file of millions of surface marine observations, including air and water temperatures and wave conditions, most of which were taken from moving ships. Computer-generated statistical summaries, tables, and charts for selected geographical areas and time periods can be produced from this file. Data products such as these were used in major portions of the U.S. Navy Marine Climatic Atlas of the World and the Summary of Synoptic Meteorological Observations produced by NCC for the U.S. Naval Weather Service Command.

NCC capabilities can contribute to the nationl marine pollution program by

- providing climatic data and analyses to determine baseline climatic conditions for selected marine or coastal areas;
- producing atlases or other publications based on data from its files, either at NCC or at institutions under contract; and
- monitoring contracts for interpretations of baseline analyses, including such studies as the liklihood of pollution-induced climatic shifts, and the socioeconomic aspects of such shifts.

iv. Environmental Science Information Center

The Environmental Science Information Center (ESIC) is responsible for NOAA's information and library services. It operates five library/information centers at NOAA facilities in the Washington, D.C., area and two in Miami, Fla. ESIC also provides functional supervision and technical assistance to NOAA field libraries. Information resources organized by ESIC deal with the atmospheric and oceanic sciences, technology and policy, and such interdisciplinary areas as energy, the environment, pollution, and resource management. ESIC's extensive collections cover a wide spectrum of topics, including cartography, climatology, fish culture, hydrography, marine pollution, marine ecology, marine fisheries, marine geology, marine geophysics, meteorology, ocean engineering, and oceanography.

Worldwide, approximately 2,500 papers are produced each year on topics related to marine and estuarine pollution. A number of relevant newsletters and bulletins are issued on a regular basis, including Coastal Pollution Research Highlights, Marine Pollution Bulletin, Marine Pollution Research Titles, and Marine Resources Digest/Marine Biology Digest.

At present, access to this information can be difficult because there is no single source from which to obtain it. ESIC, with its current resources and organizational contacts, can provide that access.

One of ESIC's most important services is its computerized literature search service. This service can easily and quickly sort through the hundreds of thousands of published papers to find marine Pollution-related material scattered in many sources. Computerized literature searches provide information from over 80 data bases, such as Oceanic Abstracts, Pollution Abstracts, Aquatic Sciences and Fisheries Abstracts, Energyline, Enviroline, Environmental Impact Statements, and the National Technical Information Service (NTIS). Services available from ESIC centers include:

- Custom literature searches in which information on a specific topic is selected from the relevant bibliographic file(s), providing referral to published literature or ongoing research projects in areas selected by the requestor.
- Selective dissemination of information, a current awareness feature in which citations are selected from the recent literature and provided periodically to users with long-term requirements.
- Packaged searches that are generated in anticipation of a need for information on high-interest topics, such as coastal zone management, marine corrosion, and oil spill cleanup.
- Searches for review articles that serve as briefings on environmental problems by providing overviews of the issues involved and documented by selected annotated bibliographies.
- Searches of data referral files of the Environmental Data Index (ENDEX), a computer-searchable inventory of interdisciplinary files of environmental data, maintained by EDIS' National Oceanographic Data Center.

In addition to computerized custom searches of literature, normal library information and reference services, and other direct services to users, ESIC also plays a major role nationally and internationally in organizing marine-related published information for access.

Nationally, ESIC is the channel through which all NOAA-, Sea Grant-, and IDOE-sponsored reports reach the National Technical Information Service (NTIS)--the central source for the public sale and permanent availability of Government-sponsored research, development, and engineering reports. NTIS publishes summaries of newly received reports in a series of weekly newsletters, the most relevant one being "Ocean Technology and Engineering."

Internationally, ESIC represents the United States in the international Aquatic Sciences and Fisheries Information System (ASFIS), which was developed under the aegis of the United Nations Food and Agriculture

Organization (FAO), the Intergovernmental Oceanographic Commission (IOC), and the United Nations Ocean Economics and Technology Office. ASFIS is a global program for providing access to information on the science, technology, and management of marine and freshwater environments and related economic and social impacts. In addition to the three international agencies, ASFIS has input centers in the United States (ESIC), the Soviet Union, the United Kingdom, the Federal Republic of Germany, France, Canada, Mexico, and Portugal. The cooperative efforts of these organizations result in Aquatic Sciences and Fisheries Abstracts (ASFA), the world's largest and most comprehensive data base of literature on the science, technology, and management of the marine and freshwater environments. Through a contract with the Lockheed Information Systems Co., ESIC makes this data base available to the public for computer searching.

ASFA provides extensive coverage of published information on marine pollution as well as ocean policy, ocean technology and engineering, oceanography, marine biology, and fisheries and other marine resources. Marine and estuarine pollution information is covered extensively under the headings:

Pollution of the aquatic environment

- General
- Methods and instruments
- Characteristics, behavior, and fate
- Monitoring and surveillance
- Prevention and control
- Effects on organisms

ESIC, as the American center for ASFA, has established a close working relationship with its English counterpart, the Marine Biological Association of the United Kingdom, which operates the Marine Pollution Information Center. The latter publishes Marine Pollution Research Titles, probably the most complete service devoted solely to that topic.

Other abstracting and indexing services relevant to marine pollution and available through ESIC include Oceanic Abstracts and Pollution Abstracts. Oceanic Abstracts provides coverage of oceanography, marine pollution, coastal resources, and ocean engineering. Pollution Abstracts is one of the best references to environmentally related technical literature on pollution, its sources, and its control.

As part of its national role, ESIC shares with several other Federal agencies the sponsorship of the Model Interstate Scientific and Technical Information Clearinghouse (MISTIC). MISTIC is operated by the National Conference of State Legislatures. It provides a means for exchanging technical information between State legislatures and the expertise located in Federal agencies. State legislatures have shown interest in such marine pollution-related topics as laws covering liability for cleanup of oil spills.

v. Center for Environmental Assessment Services

The Center for Environmental Assessment Services (CEAS) provides assistance to interagency and internal NOAA programs, including those on ocean pollution research and development. Services include data management support, quality control on special data sets, contract monitoring and coordination for environmental assessment programs, summarization and synthesis of environmental data, and impact assessment for spills of hazardous materials. CEAS presently is performing complete data management services for the Ocean Dumping Program to ensure that the collected field data are properly documented and placed in the data archives in accordance with agreed schedules and formats. Rigorous quality control measures are being applied on special solar radiation data collected by the National Weather Service. These data are intended for use as baselines in assessing effects of climatic change and pollution. Similar rigorous quality control has been performed on selected STD, XBT, and current meter data.

Under contract to the Department of Energy, CEAS is coordinating and monitoring contracts to assess the effects of brine disposal into the Gulf of Mexico from the Strategic Petroleum Reserve. As part of this effort, CEAS developed the data management plan for the program. As resports and data are received from field programs, CEAS personnel synthesize the information into environmental impact assessments and statements.

Under contracts to the Bureau of Land Management (BLM), CEAS has summarized and interpreted historical physical oceanographic and meteorological data for use in leasing decisions by BLM. The regions studied include the Mid-Atlantic, Georges Bank, and California Outer Continental Shelf. The summaries and interpretations include wind and wave fields and oceanic circulation. They provide baseline data for determining possible movement of pollutants. In addition to satisfying BLM's need, the studies demonstrate the value of the archive holdings and are being used to develop new techniques for analyzing and using archived data in environmental assessments.

CEAS also has participated in responses to oil spills. This participation has included field monitoring and impact assessment of the spills. At present CEAS is actively contributing to the Hazardous Materials Response Program by developing response plans and methodologies for conducting damage assessments.

vi. EDIS Liaison Offices and Regional Coastal Information Centers

The Environmental Data and Information Service (EDIS) also serves the user community by disseminating marine environmental data through five Liaison Offices managed by the NODC and by a network of Regional Coastal Information Centers (RCICs).

EDIS Liaison Offices are located in the major marine-oriented communities of Anchorage, Alaska, Seattle, Wash., La Jolla, Calif., Miami, Fla., and Woods Hole, Mass. The Liaison Offices primarily serve the academic and technical communities, but often assist the general public and business community. They provide data and information services to marine scientists who submit data to and receive data from NODC and other EDIS Centers.

The NOAA Regional Coastal Information Center (RCIC) Program is a new program aimed at improving access to information needed by all those involved in decisions affecting the management, conservation, and use of marine and coastal resources. Sponsored jointly by the Environmental Data and Information Service, the Office of Sea Grant, and the Office of Coastal Zone Management, the RCICs are located in Sea Grant universities and work closely with marine advisory services. Nine centers are planned for U.S. coastal areas. Three were operating at the end of 1978.

- The Northeast Coastal Information Center serves Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, and Long Island, N.Y. It is located at the University of Rhode Island and is operated by the New England Marine Advisory Service.
- The Northwest Coastal Information Center serves Oregon and Washington. It is located at the Oregon State University Marine Science Center and the University of Washington Coastal Resources Program.
- The Great Lakes Coastal Information Center serves New York, Pennsylvania, Ohio, Indiana, Michigan, Illinois, Wisconsin, and Minnesota. It is located at the Great Lakes Basin Commission and the University of Michigan.

The centers should play an important role in implementing Section 8 of the Ocean Pollution Research and Development and Monitoring Planning Act of 1978. By their charters and their locations, they are to function in close touch with the information needs of people in their respective regions. They concentrate on information brokerage--knowing how to put people in touch with sources of the information they need. They should prove useful in planning and carrying out an information dissemination program. The centers provide a link to the information requirements of State agencies and legislatures, county and city planners, citizen groups, and others. The centers already opened are disseminating information on both the technical and legal aspects of marine pollution. Because they are located in universities, the centers are staffed with well-trained specialists. They are not subject to civil service hiring ceilings, and they can be easily expanded.

b. National Technical Information Service

The National Technical Information Service (NTIS) was established in the Department of Commerce in 1970 as a clearinghouse for technical information. NTIS is the central point in the United States for the public sale of Government-funded research and development reports and other analyses prepared by Federal agencies, their contractors, or grantees. NTIS also is a central source for Federally generated machine-processable data files and manages the Federal Software Exchange Center.

The NTIS information collection exceeds one million titles. All are available for sale in paper copy or microform. NTIS ships about 20,000 information products daily. It is one of the world's leading processors of specialty information. Its user products and services include:

- o Summaries of over 500,000 Federally sponsored research reports completed and published from 1964 to date; which can be located using the agency's online computer search service (NTISearch) or the more than 1,000 Published Searches in stock.
- o The NTIS Bibliographic Data File (on magnetic tape), which includes published and unpublished abstracts and is available for lease.
- o Current summaries of new research reports and other specialized information in various categories of interest, which are published in some 26 weekly newsletters (Weekly Government Abstracts, which includes the series Environmental Pollution Control).
- o A standing order microfiche service, Selected Research in Microfiche (SRIM), which automatically provides subscribers with the full texts of research reports selected to satisfy their individual requirements.

Through agreements between NTIS and Federal research-sponsoring organizations and Special Technology Groups, NTIS is collecting and disseminating much information about ocean pollution.

3. U.S. DEPARTMENT OF DEFENSE

The Department of Defense (DOD) has a relatively small role in the overall ocean pollution program. The U.S. Navy is concentrating primarily on the need to comply with regulatory standards for shipboard and shorebased waste disposal systems. The U.S. Army Corps of Engineers is primarily interested in waste disposal in association with their civil works responsibilities in waterways management. There are no organized data and information systems devoted to ocean pollution in DOD. The relatively small programs are included within the overall research and development structure and share those management systems.

Budget and Management Information -- The Defense Documentation Center (DDC) forms the nucleus of DOD's research and development management information system. Each DOD project and task summary is entered into DDC and can then be retrieved by any qualified requestor. Individual program and project budget information is maintained by the Services and in the Five-Year Defense Plan (FYDP), which provides the basic fiscal planning document for all of DOD.

Data and Information Systems -- Although no specific data information system exists for ocean-pollution-related activities, DOD has an extensive capability for real-time environmental data bases. The Navy's Fleet Numerical Weather Central at Monterey, Calif., contains the most complete real-time oceanographic data base currently in existence. The Air Force Global Weather Central at Offutt Air Force Base, Neb., has a real-time atmospheric data base which contains the latest global meteorological observations and analyses. These data bases are designed for real-time support to military forces worldwide. Much of the data subsequently is archived by the Navy and Air Force for later climatic use. The Office of Naval Research has a development program concerned with the automated handling of large quantities of alphanumeric ocean-related environmental data.

Output Products -- Most of the projects on ocean pollution research and development have, as their final output, systems for waste disposal or techniques for evaluating pollutant effects and abatement. Project reports are completed on each project and are published as an integral part of the research program. The reports generally are available to qualified requestors through the Defense Documentation Center.

4. U.S. DEPARTMENT OF ENERGY

The primary information resource of the Department of Energy (DOE) is the Energy Information Data Base (EDB) operated by the DOE Technical Information Center, which covers all scientific and technical information of interest to the Department. It was established primarily as a bibliographic data file relating to research, development, and demonstration projects on all aspects of energy, and had its genesis in the information programs of the former Atomic Energy Commission and former Energy Research and Development Administration (ERDA).

Earliest EDB information was digitized in standard formats for computer retrieval with scope and coverage to suit the requirements of Nuclear Science Abstracts, which ceased publication June 30, 1976. Initially only citations and subject indexing information were provided for the computerized data file. In 1974, EDB began to be enriched through the introduction of large quantities of information on solar energy, coal (gasification, liquefaction, and desulfurization), and geothermal energy. When ERDA was formed in 1975, subject areas covered in EDB expanded more rapidly. Beginning June 1, 1976, complete abstracts were added.

The more than 1,000,000 EDB items searchable by computer are subdivided into broad subject categories, such as solar energy, geothermal energy, and energy storage. As of January 1, 1978, nearly 30,000 items were listed under the category of environmental sciences.

The Research in Progress (RIP) file contains records that characterize energy and energy-related research projects. Designed especially to provide a record of DOE research, the file also includes records of projects funded by other government agencies, Federal and State, and private industrial and research organizations.

Each project record contains the title of the project, the names of persons and organizations conducting the research, sponsoring organizations, a summary description of the project, subject indexing terms, and subject categorization. All information is machine searchable.

Assistance in the creation of this file is being provided by the Energy R & D Inventory Project, Oak Ridge National Laboratory. The publication Inventory of Energy Research and Development and other directories and analyses related to this field of information are created from this file.

The DOE data bases can be accessed by the DOE/RECON system, an interactive online retrieval system operated for DOE by the Oak Ridge National Laboratory. The system permits users to carry on a dialog with the computer, allowing them to browse through large data bases. The information can be selectively retrieved by simple commands invoked via the terminal keyboard.

5. U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

In the Department of Health, Education, and Welfare (HEW), the National Library of Medicine (NLM) has a mandate to collect, organize, store, and disseminate health-related information produced worldwide. The primary users of this material are researchers and practitioners working in the biomedical sciences; however, professionals in other fields whose work requires access to biomedical information also make use of the products and services of NLM.

Broad dissemination of the information collected is made possible through the NLM's Medical Literature Analysis and Retrieval System (MEDLARS), a computerized system consisting of a series of unique data bases. Access to these data bases is provided via online computer terminals located in about 800 health science libraries in medical schools, hospitals, government agencies, research institutions, and commercial organizations. References to journal articles, text books, and other published biomedical materials are retrieved in response to direct queries input by the user at the terminal; many of the references retrieved include an English language abstract of the cited work.

The extent to which the MEDLARS data bases contain information of value to workers in ocean pollution research and development and monitoring is unknown. Certainly, some of the biomedical publications indexed for inclusion in the data bases deal directly with ocean pollution. Others contain only an occasional article on the subject. However, owing to the broad scope of the subject of ocean pollution, the MEDLARS data bases may be responsive to many information needs of researchers in this field.

Examples of the kind of information the user can expect to find are:

- toxicity of chemicals, and pathogenicity of microorganisms, which might find their way into ocean waters;
- normal growth, nutrition, and physiology of plants and animals, including bacteria and viruses; and
- data on comparative pathological processes in various species.

Though not necessarily reported from any particular discipline-oriented point of view, the information content of this type of material is widely applicable to many areas of research, including ocean pollution.

6. U.S. DEPARTMENT OF THE INTERIOR

The Department of the Interior (DOI) has developed and now maintains a large number of data systems in support of its missions: to manage the public lands; to conserve mineral, water, and recreational resources and values of the National Domain; to assure preservation of our country's natural, cultural, and scenic heritage; and to protect the treaty rights of native American Indians. The public lands include the Nation's Outer Continental Shelves and large areas of coastal lands that have particular natural and recreational values. To accommodate needs for information to fulfill management responsibilities for these lands and the coastal and offshore components of other Interior interests, most of the Department's larger data systems include ocean-related data. Many smaller and local systems apply uniquely to coastal and offshore areas or to conditions, natural processes, or activities within them.

The identification, assessment, and control of pollution and potential for pollution constitute fundamental aspects of many Interior functions and supporting activities. Efforts include monitoring the Nation's principal network of water-gaging stations to determine the quantities and nature of water discharged from land by rivers -- a major source of ocean pollutants. They also include inspections of point-source facilities for containment of potential pollutants at public beaches and offshore oil platforms. Some data systems, such as those for pesticide monitoring of fish in the Great Lakes, are components of existing ocean pollution efforts as defined in the "National Ocean Pollution Research and Development and Monitoring Planning Act of 1978." Others, such as those supporting subsurface mineral resource assessments, involve data that has little or no direct bearing on ocean pollution problems, but might be useful in related research.

The data systems are of many types. Some are unique to the problems they address; others span the boundaries of proposed classifications. An example of the latter is WATSTORE (described below), which has subsystems that permit preliminary processing of raw input data, storage of results, and graphical and statistical treatment of outputs. The descriptions that follow include some systems that might best be classified as "information" rather than "data" systems. They identify (index) sources of data, but do not provide data as such. Examples are NAWDEX and WRSIC. To avoid repetition, and for practicality, systems operated in support of specific functions or research are grouped together.

a. Bureau of Land Management

The Bureau of Land Management (BLM) manages Natural Resource and National Mineral Lands, including extensive lands in the coastal zone, especially in Alaska. BLM is responsible for the Outer Continental Shelf Leasing Program, including preparation of Environmental Impact Analyses. In support of this work, BLM has a group of data collection and data management systems. Also, contracts for environmental studies contain stipulations that data and results be deposited with appropriate data-base management components of NOAA/EDIS and other agencies.

b. Fish and Wildlife Service

The Fish and Wildlife Service (FWS) coordinates full consideration of fish and wildlife conservation with other features of Federal and private water-resource development programs; manages fish, shellfish, and wildlife resources; conserves, develops, and enhances the Great Lakes fishery resources; and performs other duties mandated by the Endangered Species and Migratory Bird Acts.

The Division of Ecological Services maintains a data (project) management and analysis system in support of habitat evaluation procedures applicable to coastal waters. It provides a data base for review of water-resource development permits and for operation of fish and wildlife conservation facilities.

The Denver Wildlife Research Center has a data storage and retrieval capability for pesticide residues. Specifically, it receives inputs from projects and associated data management systems such as the one devoted to identifying trends in space and time of organochlorine and related components in wetland bird species (including those that use coastal and offshore flyways).

Environmental assessment of the Great Lakes fishery resource is the function of FWS's Great Lakes Fisheries Laboratory, which uses a group of data management, storage and retrieval, and processing systems. These contain routine fishery resource assessment data, a limited amount of water quality data, and commercial fishery statistics.

The Office of Biological Services has developed a number of data systems for organizing data and associated knowledge about biological resources and their habitats (ecosystems). The following types of systems are contained in this Biological Services Program:

- Textual systems, such as the Sensitive Wildlife Information File, and bibliographic files of Coastal Ecosystems Documents and Shoreline Structures Documents.

- Geobased systems, such as the Wetland Analytic Mapping System and Aquatic Resources and Contaminants file.
- Modeling systems, such as the Three-dimensional Intake Model for predicting fish entrainment and impingement.
- Multiple-mode systems, such as the Colonial Nesting Bird Survey and the Alaska Information Management System.

c. Heritage Conservation and Recreation Service

The mission of the Heritage Conservation and Recreation Service (HCRS) is to prepare a nationwide plan setting forth policy and providing guidance for outdoor recreation activities -- to inventory, evaluate, and classify outdoor recreation resources. HCRS uses data management and processing systems to accumulate and analyze recreation information, and to coordinate national recreation planning with State and regional comprehensive development, land use, and recreation planning.

d. National Park Service

The National Park Service (NPS) is mandated to promote and regulate the use of Federal areas assigned to the National Park System for purposes of conserving the scenery, natural and historic objects, and wildlife therein, and providing for their enjoyment in such a manner and by such means as will leave them unimpaired for enjoyment of future generations. Within the coastal zone, the Park Service operates about 30 large units (national parks, monuments, lakeshores, and seashores) and many small ones (historic sites, etc.).

Planning and operating the National Park System involves the development and use of a variety of data systems that have direct or indirect bearing on knowledge of ocean pollution. In addition, NPS encourages use of Park Units as bases for research by qualified investigators. Four representative examples of current activities that involve data management and bear on ocean pollution are: (1) forecasts of visitor uses and social behavior on beaches for planning facilities, (2) an assessment of human impacts on coral reefs and ecosystems along underwater nature trails, (3) survey of Everglades wading bird populations, and (4) gaging the quantity and quality of water in stream waters entering and leaving park units. Many activities, such as the last of these examples, provide inputs to comprehensive data systems.

e. Office of Water Research and Technology

The Office of Water Research and Technology (OWRT) develops knowledge used to solve high-priority water resource problems existing in the various States and hydrographic regions of the Nation. It supports State Water Resources Research Institutes (Title I grants); provides matching grants to the Institutes (Title I grants); and supports additional Water Resources

Research (Title II grants). OWRT also is active in desalination technology including materials research that has direct relevance to ocean pollution research. It has developed water resources data systems applicable to water quality management and protection and to network design, data acquisition, data evaluation and processing, and to publication. It also maintains data management systems related to desalination materials and processes.

The Office provides a comprehensive information service through the Water Resources Scientific Information Center (WRSIC), which accesses on-line bibliographic data bases for reference to the published literature. About 5 percent of the material in the literature base is estimated to be directly or indirectly relevant to ocean pollution research and development and monitoring.

f. Bureau of Mines

The U.S. Bureau of Mines conducts scientific and technological studies of all aspects of mining and the mining industries, from the preparation, treatment, and utilization of mineral substances, to economic conditions affecting the mineral industries. The Bureau's Research Information Management System (RIMS) and its data management and processing systems help support assessment of mining technology and practices used in coastal and offshore mining and dredging; studies of waste (spoils) disposal; and studies pertaining to beneficiation of potential deep-sea manganese nodule ores. It has comprehensive data management, storage, retrieval, and analysis systems for supplying information on minerals, materials, and mining to State Coastal Zone Management Programs for use in analyses of offshore mineral development impacts. Similar systems are also used for collecting and disseminating voluntarily-supplied information on metallic and nonmetallic mineral reserves, production, consumption, stocks, trade, etc., for both domestic and foreign land-based and water-based operations.

g. Geological Survey

The mission of the U.S. Geological Survey (USGS) is to classify the public lands; examine geologic structures, mineral resources, and products of the National Domain; conserve and prevent waste of Outer Continental Shelf (OCS) natural resources and protect correlative rights; and study the occurrence, quantity, quality, distribution, and movement of the Nation's surface and subsurface water resources. The USGS conducts basic research on many topics that have applicability to the solution of problems relating to the sea floor as well as to the land. Some of this research utilizes data collected from the marine environment, whereas other research provides results or techniques applicable to interpretation of marine data, including ocean pollution data. For example, data systems for clay mineral exchange capacities relate equally to studies concerning the fate of polluting trace elements regardless of whether the clays are components of sediments forming uplands or the sea floor. Other examples include: (1) carbon-isotope studies to identify hydrocarbon sources, (2) organo-geochemical studies of hydrocarbon diagenesis to form coal and petroleum, and (3) paleontological analyses of biologic debris. Still others with direct application could be cited. And, if projects with indirect application are included, most projects dealing with surficial geological materials and processes could be included.

The Office of Marine Geology in USGS's Geologic Division has a grouping of data collection, data management, and data processing systems to support offshore environmental geology studies. The Office examines surficial geology, shallow geologic structure, and geologic processes of the OCS to identify, locate, and characterize geologic hazards that must be considered in oil, gas, and mineral development, and to determine potential impacts of development on the geologic environment. This group of data systems includes collection and processing of a wide variety of geological, geochemical, geotechnical, and geophysical data such as high-resolution sonic and seismic profiles, results of organochemical and trace element analyses of sediment samples, and paleontologic and mineralogic identifications. Data having archival value is made available to the National Geophysical and Solar-Terrestrial Data Center (NGSDC) of NOAA/EDIS and to other data storage and retrieval systems as appropriate.

The Office also has a group of data systems related to marine geologic studies. These systems interface with those of applied marine geologic resources and geoenvironmental studies. They are problem-oriented and mostly have indirect, limited, or peripheral applications to problems of ocean pollution. A few, however, such as one devoted to a detailed hydrologic/geologic study of the San Francisco Bay Region, contain abundant data of direct, but local, application.

USGS's Conservation Division performs assessments of available public and proprietary data pertaining to environmental conditions and risks of areas and tracts proposed for OCS oil, gas, and sulphur lease sales. This work includes data collection and processing for areas of insufficient data. High-resolution seismic profiles and other collected data are made available through NGSDC. This Division also maintains an OCS Events File for handling data concerning spills, accidents, and other mishaps associated with offshore oil, gas, and mineral operations. The file contains data on time, location, causes, and nature for all accidents, failures, and other events that relate to petroleum operations on the OCS and involve spills of a barrel or more of oil, as well as other contaminants, facilities, and major damage. The system interfaces with inspections, accident, failure, well history and well status, and production reporting systems, and is updated monthly. Inputs include those submitted by operators to fulfill spill-reporting requirements (OCS Order No. 7) and by USGS inspection and surveillance teams. Data on quantities of oil spillage (pollution) range in accuracy from estimates to precise measurement, depending on the character of the various events.

The Survey's Water Resources Division maintains two systems concerned with water quality, WATSTORE (Water data storage and retrieval system) and NAWDEX (National Water Data Exchange). WATSTORE is a computerized national data storage and retrieval system with provisions for processing selected raw input data and for graphical and statistical treatment of output data. As the Nation's largest source of water data, WATSTORE processes and incorporates more than 180 million measurements daily including those of a number of subsystems. Among subsystems, the National Stream Quality Accounting Network (NASQAN) provides data on the quality of waters discharged to the oceans by rivers of the Nation's major watersheds. Supplemented by data inputs from other sources, WATSTORE is the single most important source of data on ocean pollutants discharged from land areas (including the freshwaters of floods). WATSTORE interfaces with EPA's STORET and other major water and pollution data systems. Inputs from sources outside the USGS gaging system are significant, but still limited.

NAWDEX is an information system used to identify and describe water data sources; it provides a mechanism to assist users identify, locate, and acquire water data. NAWDEX depends on input from public and private water-oriented organizations, which together constitute a national confederation of the majority of organizations that collect water data for public use. The system forms the basis for products such as the "Catalog of Information on Water Sources" issued by the Office of Water Data Coordination within the USGS Water Resources Division. The system interfaces with WATSTORE and others, providing methods for updating information. Relatively complete and current for the majority of Federal, State, and other public organizations, NAWDEX has known gaps in information, mostly related to data from private sources.

7. U.S. DEPARTMENT OF TRANSPORTATION

The Federal Water Pollution Control Act (Section 311) requires that any discharge of an oil or a hazardous substance in a harmful quantity be reported to the "appropriate agency of the United States Government." Executive Order 11735, March 5, 1970, designated the Coast Guard within the Department of Transportation (DOT) as one of these agencies.

The Pollution Incident Reporting System (PIRS) is a computerized data base developed in December 1971 as an adjunct to the Coast Guard's Marine Environmental Protection Program. Initially designed for the collection and maintenance of discharge data, subsequent modifications were made in 1972 to permit the inclusion of additional data on cleanup (response) activities and penalty actions. The following are the data PIRS collects for pollution incidents:

Discharge	Response	Penalty
Time of occurrence	Cleanup party	Initiating agency
Location	Equipment used	Authority
State	Personnel	Action against
Waterbody	Cleanup duration	Action date
Source	Amount recovered	Penalty proposed
Cause	Cleanup cost	Penalty collected
Operation		Hearing results
Material		Appeal results
Quantity		Case status
Notifier		

Concurrent with the 1972 modifications, a sophisticated report generating language (SPECTRAN) was incorporated into PIRS, providing greater flexibility in structuring both report content and format.

The system can be programed to produce repetitive listings of spills meeting predetermined criteria. Any or all data fields can be retrieved for each spill listed, depending upon the requirements of the eventual user. For applications not requiring such detail, as when statistical analysis or summations involving specific data items are required, SPECTRAN provides the necessary flexibility to generate reports in this type of format.

Requests for data from PIRS are processed at Coast Guard Headquarters only, and because the type of data involved is not critical in situations requiring rapid response, the requests are processed in batch mode environment. The average length of time required for processing, from receipt of the request until final product, is 3 days.

PIRS functions in a dual capacity, as a resource utilized by the Coast Guard in management of its Marine Environmental Protection and as a resource available to Congress, academia, private firms, and individuals.

8. U.S. ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) was established in December 1970 as an independent agency in the executive branch. Its mission is to control and abate pollution in the areas of air, water, solid waste, pesticides, noise, and radiation; its mandate is to mount an integrated coordinated attack on environmental pollution in cooperation with State and local government. EPA maintains two data and information systems that are relevant to the Federal ocean pollution program. These systems are called STORET and ORDIS.

a. System STORET

STORET is an acronym used to identify the computerized data base system maintained by EPA for the STOrage and RETrieval of data relating to the quality of the waterways within and contiguous to the United States. The system encompasses not only the centralized data base of water quality data, but also the associated software for storing and retrieving data on water quality, water quality standards, point sources of pollution, pollution-caused fish kills, waste abatement needs, implementation schedules, and many other water quality related items.

STORET serves as a central repository for all water quality and related data collected by EPA and many other contributing agencies and organizations. States and other organizations can use the data for their own local pollution abatement efforts, while those concerned with national programs can review the data in broader perspectives. The pooling of data into a central data base contributes significantly to the value of the data base through the benefits of multiple use and sharing of data. The Water Quality File (WQF), the largest STORET file, contains data from the monitoring of streams, rivers, lakes, and other bodies of water within and contiguous to the United States.

Two basic types of data are included in the Water Quality File: station data, which describe and categorize the geographic location where samples were taken; and parametric data, which describe the conditions under which samples were taken (such as date, time, and depth) and results of sample analyses. The number of unique collection points, or stations, in the Water Quality File has grown from about 150 in 1964 to more than 200,000 in 1976.

Output products include tabular listings of data values, statistical summaries of parameter values, and graphic plots (including line printer or precision plots) of sample values or statistical analyses. Plotting capabilities also include station location plots which readily illustrate monitoring coverage over a selected geographical area. Violations to established water quality standards, on an individual or summary basis, may be reported.

The Fish Kill File provides nationwide information on major pollution-caused fish kills which result from a variety of industrial, municipal, agricultural, and transportation-related operations. A fish kill is usually first noticed by a fisherman, camper, or sportsman who, as an interested and concerned private citizen, reports the kill to a State official. In most instances, the State agency sends trained specialists to investigate and identify the size and cause of the kill. These specialists sometimes request the help of Environmental Protection Agency field personnel to assist in onsite investigations, or to make laboratory analyses of dead fish tissue samples. When water pollution is determined to be the cause of the kill, the State submits a report to the Environmental Protection Agency. Information from these reports is entered into the Fish Kill File, which contains fish kill data back to 1960, and from which fish kill summary reports are easily obtained.

The Municipal Waste Inventory File serves as the repository for data on municipal waste sources and disposal systems, and holds data from all communities and/or municipal waste facilities, including those privately owned, within the United States. This file is used to provide input to the preparation of basin plans, annual budgets, and annual reports (such as EPA's Cost of Clean Water report), to support periodic assessments of the effectiveness of control or abatement measures, and to help monitor the degrees of compliance with standards.

STORET is used by a variety of governmental agencies and other organizations to achieve numerous objectives relating to water quality assessment and management. New uses are conceived every day to solve new problems or to perform different analyses of data in light of changing or emerging water quality situations.

The STORET Contract Awards File helps interested individuals and organizations track the progress of the thousands of contracts awarded by municipalities for construction of sewage facilities, compile statistics on the nature of these awards, and quantify any patterns or trends. The construction grant program, a major element of the 1956 Federal Water Pollution Control Act, authorized the Federal government to award funds to municipalities to help finance construction of sewage treatment facilities. Although this initial legislation appropriated only $50 million per year in grant funds, the program has grown substantially and grant funds of $18 billion and $25 billion were later authorized. Awards dating back to 1952 are contained in the file.

b. System ORDIS

The Environmental Protection Agency's Office of Research and Development (ORD) has responsibility for more than 4,000 ongoing research projects supported by its $300 million annual research budget. ORD's research program is managed and conducted by its 24 Responsibility Centers (which include 6 headquarters offices, 2 field administrative offices, 1 research information center, and 15 laboratories) located throughout the country, and by a dozen other Federal agencies and numerous contractors and grantees.

The task of coordinating projects and budgeting ORD resources is complex and requires the support of a comprehensive information system. Such a system was initiated in September 1977 and has been termed ORDIS, the Office of Research and Development Information System. Although still under development, ORDIS has already proven its value as both a management tool and an information source.

When ORDIS is complete it will be composed of five interrelated packages: Research Program, Financial Resources, Personnel, Administrative, and Display Analysis. Currently ORDIS concentrates on information in two primary areas, research project information and resource data. As a technical information source, ORDIS contains details on individual research projects and ORD's use of its resources in support of project goals. As a resource data source, ORDIS supplies indepth information on the specific status and disbursement of funds and on the distribution and utilization of manpower. With the assistance of the information, management is able to review both the specific content and status of the research program, and the allocation of resources to assure that ORD can meet salient agency needs and goals.

ORDIS is designed with certain principles in mind. These principles are: compatibility with existing systems, flexibility, a minimal drain on ORD personnel, and cost efficiency through the use of existing systems. For example, the Financial Management System is an extension of EPA's Financial Management Division's system and the Project Tracking System is an outgrowth of a similar activity of the Smithsonian Science Information Exchange (SSIE).

The information stored in the ORDIS project data files is accessible through the use of the Project Tracking System (PTS) which contains basic information on individual ORD research projects as well as inhouse managerial functions. In particular, it contains an abstract of the project, the principal individuals involved, and information on the project's funding.

By mid-November of 1978 more than 4,000 Project Information data forms will have been completed by ORD project officers.

Although PTS is used by ORD managers to track and report project funding and progress, perhaps the real usefulness of the system lies in its value as a research tool to independent researchers, other EPA offices, and other agencies. Through the use of the flexible and comprehensive keyword directory and other PTS search methods, the various ORDIS/PTS users can tap the project data files to identify the answers to any number of questions by using the data in the system, or by carrying the investigation any number of steps further by contacting individuals named by PTS as project officers or principal investigators.

9. U.S. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Among the responsibilities of the National Aeronautics and Space Administration (NASA), which was established by the National Aeronautics and Space Act of 1958, is the conduct of research and development activities leading to programs that demonstrate the applications of space systems, the space environment, and space related and derived technology. These activities involve disciplines such as meteorology, earth resources survey, earth and ocean physics, and pollution monitoring.

NASA has two primary data and information systems that support ocean pollution research and development and monitoring activities. The first of these is the Atmospheric and Oceanographic Information Processing System maintained at NASA's Goddard Space Flight Center, Greenbelt, Md. This system handles data from satellites, aircraft, and sounding rockets, and processes the same into lineprint copy, photographs, false color maps, and other forms. It also allows interactive TV display for user inputs. The mission of this system is to provide applications interactive data analysis for meteorology, hydrology, geology, land use studies, and the agricultural disciplines. Its principal advantage is that it is a central facility having a consistent data base.

The second primary system is the NASA Scientific and Technical Information Facility, which catalogs all NASA reports, journal articles, and papers, and information from other organizations that relates to NASA subject areas. The Facility maintains a data base for all NASA publications, provides to users copies of all NASA documents including subject printouts, books, papers, articles, and films.

Through its Eastern Regional Remote Sensing Applications Center, NASA is involved in transferring satellite remote sensing technology to State and local governments. At the Center, users are trained to use remote sensing technology as an aid in better carrying out their responsibilities and functions. Major problems encountered in this effort are: (1) users do not have resources (time, manpower, funds) to explore new technology; and (2) users do not have an administrative and operational environment conducive to cost effective use of the technology.

III. RELATIONSHIPS OF PROGRAMS/SYSTEMS/AGENCIES

A. Users of Ocean Pollution Data and Information

Precise information about users of ocean pollution data and information is not available. A number of agencies maintain statistics on the number of users they serve, but do not survey the exact application of the data and information provided -- whether for ocean-pollution-related information need or for some other purpose. NOAA's Environmental Data and Information Service (EDIS) is a useful example because it provides a large number of marine environmental data and information services to a large number of users of ocean pollution data and information. EDIS keeps annual user statistics both by EDIS Center and by six classes of user: foreign, academia, industry, NOAA, other government, and general public. Table 1 summarizes EDIS statistics by user category for the years 1974 through 1977 (1978 figures are not yet available). Although there are fairly large year-to-year variations, there also are several apparent trends:

- o Total EDIS user requests show a uniform increase of about six percent a year.
- o Requests from academia and foreign sources continue nearly constant.
- o Requests from industry and other government sources show a moderate increase.
- o The greatest percentage increases are registered by NOAA inhouse users and by the general public.

These figures and trends corroborate a commonly expressed feeling of many environmental information specialists, and the subjective opinion of the Subcommittee that:

1. The demand for all types of marine environmental data and information, and especially ocean pollution data and information, is steadily increasing; and
2. The greatest increase in demand for ocean pollution data and information will be among nontechnical or, perhaps more precisely, nonspecialist users such as policymakers, environmental managers, concerned citizens, and others with broad, multidisciplinary interests.

Therefore, while any comprehensive ocean pollution data and information system will continue to serve many users with single-discipline needs and interests, it also must provide efficient accessibility of data and information to a wider and larger user community. Measures to make multidisciplinary or cross-disciplinary use easier must be encouraged.

Table 1.—EDIS user requests by category, 1974-77

User category	1974	1975	1976	1977
Foreign	3,663	3,990	4,310	3,954
Academia	10,963	10,393	10,753	9,572
Industry	18,985	20,075	20,163	22,940
NOAA	4,567	5,568	8,105	7,155
Other government	9,455	9,948	10,678	11,038
Public	26,747	28,783	30,343	34,469
Total:	74,380	78,757	84,352	89,128

B. Federal Agency Coordination

The Departments of Agriculture, Commerce, Defense, Energy, HEW, Interior, and Transportation, and EPA have developed a large number of data and information systems to support their missions. The Subcommittee considered these systems and their wide variety of design to perform special functions. The systems are of many types. Some are unique to the problems they address and the users they attempt to serve. Representative interrelationships among Federal agencies are summarized.

1. DEPARTMENT OF COMMERCE

a. NOAA Environmental Data and Information Service (EDIS)

EDIS acts as a national archive for oceanographic, meteorological, and geological/geophysical data. EDIS's three primary data centers (NODC, NCC, and NGSDC) have developed operational ties with agencies generating these types of environmental data for the primary purpose of serving secondary data users. EDIS is base funded to provide the capability for handling the data. Retrieval of data is on an actual cost basis (cost of retrieval).

EDIS maintains formal data policy relationships with a number of Federal agencies. These agreements provide for the orderly accession and archival of environmental data collected by certain Federal agencies. Agreements covering oceanographic data presently are in force with the Oceanographer of the Navy, Geological Survey (marine geology/geophysical data), National Science Foundation, U.S. Coast Guard, and NOAA Office of Sea Grant. For NOAA's marine programs, NODC endeavors to provide data management support at the project level rather than the national level. Except for Sea Grant programs, there is no formal relationship with other agency programs below the Federal level. This is not to say, that occasionally environmental data is not received from this level of activity. Much marine data is generated by State, local, private, and academic institutions. This body of data is of considerable importance to the solution of coastal marine problems in the United States.

b. National Technical Information Service (NTIS)

NTIS is the central point in the United States for public sale of Government-funded research and development reports prepared by Federal agencies. NTIS also is a central source for Federally generated machine-processable data files and computer software. Through agreements between NTIS and Federal agencies, NTIS is collecting and disseminating information about ocean pollution.

2. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

The National Institutes of Health (NIH) National Library of Medicine (NLM) interacts with other Federal agencies in the following ways. The National Institute of Occupational Safety and Health (NIOSH) supplies the data input for NLM's computer searchable data base titled Registry of Toxic Effects of Chemical Substances (RTECS). The Food and Drug Administration, Environmental Protection Agency, and Consumer Product Safety Commission regulatory agencies and other Federal organizations have direct access to all of NLM's MEDLARS data bases. The Department of Energy through its information centers at Oak Ridge, Tenn., -- Environmental Mutagen Information Center (EMIC), Environmental Teratology Information Center (ETIC), and Toxic Materials Information Center (TMIC) -- provides NLM data for the MEDLARS file TOXLINE.

3. DEPARTMENT OF ENERGY

The Department of Energy (DOE) has data bases and information resources under several assistant secretaries. Perhaps the most important are those of the Technical Information Center (TIC) at Oak Ridge under the Secretary for Intergovernmental and Institutional Relations (such as the RECON System), and several systems at Oak Ridge funded by the Assistant Secretary for Environment (such as the Federal Inventory of Energy Related Environment and Safety Research) -- all on computerized retrieval. These and other energy data bases are available to other Federal agencies and the public. NLM interacts with DOE through the Office of the Assistant Secretary for Environment and the information centers at Oak Ridge -- Environmental Mutagen Information Center, Environmental Teratology Information Center, and Toxic Materials Information Center.

All DOE publications are sent to NTIS. The Technical Information Center (TIC) in Oak Ridge gathers project information on all research and development within DOE and sends a tape of this information to the

Smithsonian Scientific Information Exchange (SSIE). On an international basis, the International Atomic Energy Agency and TIC/Oak Ridge use the same storage and retrieval system for nuclear energy projects (and now for energy technology). TIC provides U.S. input into this international energy information system. DOE also has an information center for the public in Denver, Colo., to which EPA and DOE's regional counsel provide input.

4. DEPARTMENT OF AGRICULTURE

The Science and Education Administration's (SEA) Technical Information System (TIS) has a full range of online data base systems, including the Current Research Information System (CRIS), a type of management information system (MIS), and AGRICultural On-Line Access (AGRICOLA), a published bibliographic data base. The output products range from bibliographies to online searches. Special catalogs, inventories, and studies are available as required by Department users.

SEA/TIS has several formal data policy relationships with Federal agencies. The AGRICultural On-Line Access (AGRICOLA) file contains citations on ocean pollution. The American Agricultural Economics Documentation Center (AAEDC) provides TIS the bibliographic data for its computer searchable AGRICOLA data base subfile titled Agricultural Economics (AG ECON). The Marketing and Trade Division, Economics Branch, Canada Agriculture, Ottawa, provides citations on Canadian agricultural economics publications. The Food and Nutrition Information Center (FNIC) provides citations on nutrition in AGRICOLA. The Animal and Plant Health Inspection Service (APHIS) provides bibliographic records on Brucellosis disease control for the AGRICOLA file. All of these agencies and the public have access to AGRICOLA. Efforts are underway to exchange information with the Department of Energy on agriculture-related research in progress, particularly solar energy. Other efforts are planned to convert agriculture-related bibliographic files in several Federal agencies to AGRICOLA. The Current Research Information System (CRIS) file on agriculture projects is provided to the Smithsonian Science Information Exchange (SSIE).

At the international level, the AGRICOLA tape is provided to the Food and Agriculture Organization (FAO), Agriculture Information System (AGRIS). Approximately 50 percent of the file is converted into AGRIS. Efforts are underway to create an AGRICOLA file that will be compatible with AGRIS, which will allow full input of AGRICOLA into AGRIS.

SEA/TIS interacts with NLM and the Library of Congress, and uses both their data base systems. In addition, SEA/TIS cooperates with DOE and has access to RECON energy data bases at Oak Ridge and has exchanged CRIS-type data on agriculture-related energy projects.

5. DEPARTMENT OF DEFENSE

The Defense Documentation Center (DDC) receives reports of projects on ocean pollution research and development. These reports when unclassified are available to qualified requestors through DDC. Each DOD project and task summary is reported to DDC by the services and can be retrieved by any qualified requestor. Individual program and project budget information is maintained by the services and incorporated into the Five-Year Defense Plan (FYDP) of DOD.

6. DEPARTMENT OF THE INTERIOR

Data having archival value is made available to the National Geophysical and Solar-Terrestrial Data Center (NGSDC) of NOAA/EDIS and other data storage/retrieval systems as appropriate. The Geological Survey WATer data STOrage and REtrieval system (WATSTORE) and National Water Data Exchange (NAWDEX) interface with EPA's STORET and with major water and pollution data systems.

7. DEPARTMENT OF TRANSPORTATION

The Coast Guard processes requests for data and information in the Pollution Incident Reporting System (PIRS) at their headquarters only. There is no formally established coordination or referral program; however, when other data bases are known to be more responsive to an inquiry, requests are forwarded to the appropriate Federal agency.

8. ENVIRONMENTAL PROTECTION AGENCY

EPA's STOrage and RETrieval (STORET) data system is used by many governmental agencies for water quality and assessment needs. STORET interfaces with Interior's USGS NAWDEX system. The Municipal Waste Inventory File is a repository for data on municipal waste sources and disposal systems. It provides the needed data input to prepare basin plans, annual budgets, and reports, and to help monitor the degree of compliance with standards. The EPA Office of Research and Development Information System (ORDIS) interfaces with the Smithsonian Science Information System (SSIE) and eventually will be linked to NTIS. The information in ORDIS project data files is accessible through the use of the Project Tracking System (PTS). ORDIS contains information on the funding and purpose of projects and can be searched by keyword.

C. Potential Problems

The Council on Environmental Quality (CEQ) through the Water Working Group of CEQ's Interagency Task Force on Environmental Data and Monitoring has identified several problems that are pertinent to interagency coordination of data and information activities.

- Coordination of data and information services is not adequate, in part because of fragmentation of responsibilities.

- There is greater need for data interpretation.

- Systems lack the technical and/or organizational capability to look (search) different types of data (cross discipline) simultaneously.

The above are general statements of difficulties encountered, but are indicative of severe limitations in the environmental data handling capabilities in the United States today. Overall there is no comprehensive set of formal arrangements within the Federal agencies coordinating the various types of data and information that are generated or derived from ocean pollution research and development. It should be noted, however, that a number of agencies have established bilateral relationships. For example, the USGS and NOAA have a joint coordination committee that has met monthly for some years.

IV. ASSESSMENT OF CURRENT CAPABILITIES[1]

The President forwarded his 1977 Environmental Program to the Congress on May 23, 1977. The message included the following directive: "I am also directing the Council on Environmental Quality to establish an interagency task force to review present environmental monitoring and data programs, and to recommend improvement that would make these programs more effective." This directive was based, in part, on the following concerns about the Nation's environmental monitoring programs; "more than a hundred Federal programs from nearly every major agency presently generate data, statistics, and analytical information about environmental conditions, trends and their causes. We depend heavily on information from these programs, many of which are well conducted ... Yet, there are major deficiencies. Large gaps, wasteful duplications, questionable validity, and lack of coordination characterize many of the nation's environmental monitoring and data programs. Lack of uniformity often prevents a comparison of one agency's data with another's. Inadequate quality assurance often reduces the scientific credibility of data and therefore its usefulness to decisionmakers. Important data are often collected but not well disseminated or made available to analysts efficiently and decisionmakers." (Fact Sheet accompanying 1977 President's program, Council on Environmental Quality, May 23, 1977)

Later in 1977 the chairman of the Council on Environmental Quality established an interagency task force on environmental data and monitoring. A subgroup of this body, the Water Working Group, met in November 1977 to inventory water data and monitoring activities, and to consider problems and issues in water data monitoring. While the majority of the group's consideration was directed toward the problems of freshwater data and monitoring, consideration of marine problems occupied a significant part of the group's attention.

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[1] Adapted from Summary Report for FY-78, Distribution Draft - December 13, 1978, Water Working Group. CEQ Interagency Task Force on Environmental Data and Monitoring.

The Water Working Group notes that 20 Federal agencies are concerned with the collection and use of water data and that the needs for processing, storing, and interpreting the resultant data are generally inadequately met by the several dozen existing data systems.

The group considered in detail the problems of these data systems. It was found that these systems generally suffer from a lack of data quality standards, an inability to compare and correlate data from different disciplines, and the inability of users to gain access to data files easily. The group asked several questions about the adequacy of the data system. They include the following.

Users of data: Are they served? Can they analyze the data to the full potential? Are data from all sources available and easily accessible? Should the user be required to fund the operation of Federal data systems or should they be funded by appropriation?

Data quality: Can data from different sources (but in the same discipline) be merged with confidence? Should standard methods be established to collect data, and should data collected by those methods be the only data allowed in the files?

Cross disciplinary analyses: How can data systems best support studies involving data from different disciplines? Can data on human health be correlated with environmental quality parameters? Can changes in water quality be compared with investment in pollution control?

With respect to the present Federal capability, the Water Working Group found that:

- A majority of users require data only from a single-medium and single discipline, and can be satisfied by separate systems;
- Existing Federal data systems operate successfully in meeting the needs of single government agencies and single-discipline users; and
- Cross-disciplinary analyses are becoming increasingly important for decisionmaking, but mechanisms for providing such analyses are inadequate.

The Water Working Group set out to recommend the best data system that would: improve analysis and interpretation, increase comparability of data for efficient cross-disciplinary analyses, and increase the accessibility of data to a larger user community to foster multiple use and independent analyses.

The Group recommended a system whereby only a subset of the data held by an agency would be stored within a central system. A central authority would set reporting standards and requirements. An automated referral system would allow for the location and retrieval of special subsets of data required for individual analysis requirements.

While the view of the Water Working Group was broader than marine pollution and primarily hydrologically-oriented, its recommendations are generally applicable to the problems and needs addressed by P.L. 95-273, Section 8.

V. RECOMMENDATIONS: A PROPOSED OCEAN POLLUTION DATA AND INFORMATION NETWORK

A complete data and information service network is needed to support ocean pollution research and development and monitoring activities, including planning and data management through delivery of published results. The Subcommittee on Data Collection, Storage, and Distribution has proposed a data and information network (fig. 1) to meet the needs of the general public and the special needs identified by three specially convened groups -- Estes Park, Colo., workshop on "Scientific Problems Relating to Ocean Pollutants," Tysons Corner, Va., workshop on "Ocean Pollution Needs and Problems," and the CEQ Interagency Task Force on Environmental Data and Monitoring.

The approach is responsive to the needs of secondary data users, those who use environmental data and information subsequent to the use for which the data were originally intended. Three basic components are proposed:

- The Subject Area Data/Information Center -- where numeric and textual environmental data is available and analyzed, generally covering one subject area or discipline;

- The Depository -- where textual information is available; and
- The Central Coordination and Referral Office -- where inventories of environmental data and information, and management information about ocean pollution programs, can be obtained.

A fourth component, the Data Generator (the basic source of new data), is shown in figure 1 as part of the network when actually it should be considered distinct from the proposed processing and dissemination activities.

Although the proposed activities may seem relatively distinct, and their functions clear-cut, a rigorous definition of function and extent was avoided. A natural aggregation of duties and functions should be allowed to develop in the initial stages of network implementation.

An effective data and information operation needs a substantial commitment in money and people from agency management. A percentage of the funds appropriated for ocean pollution research and development and monitoring programs should be allocated to support the data and information system program. Support in the sum of 3 percent has been found effective although 3.5 to 4 percent would better provide for all activities, such as data quality control and establishing standards.

A. Component: Data Generator

The term data generator is intended to describe any activity that originates and/or carries out ocean pollution research and development and monitoring of data. This component is not an integral part of the proposed network. The function is described because it is where the data and information originate. Types of data generated at this level include:

- management information,
- numeric environmental research and development data,
- numeric data resulting from monitoring programs, and
- analyses, reports, and other bibliographic information.

This kind of data usually results from programs pursuant to agency missions. Data generators generally are individuals, groups, or organizations that carry out research and development. It is important that data generators be clearly identified so that all pertinent ocean pollution data and information can be directed to the appropriate Subject Area Data/Information Centers as a regular function of the data generation cycle. If required, formal agreements can be arranged between the generator and the Subject Area Data/Information Center.

B. Component: Subject Area Data/Information Center

At the level of organization above the data generators, a series of Subject Area Data/Information Centers serve as depositories for numeric data, textual reports and information, management information, and referral information. The term "subject area" should not be interpreted too narrowly. The main idea is that the Centers establish and organize collections of data -- each of which is related to some phenomena, academic discipline, or perhaps a geographic area. Staffs of these Centers will become experts in their specific subject areas.

These Centers would receive copies of numeric and other data and information in their respective subject areas from data generators (who may be sending different kinds of data to more than one center). They would then process, store, and disseminate the data as required. Numeric data would tend to accumulate at this level. Normally it would rise no higher in the network than these Centers. In addition to providing requesters data and information from automated data bases, these Centers would produce catalogs, bibliographies, or other data products. They also might provide analyses of summarized data from completed research projects, or general analyses of work being done in their subject area.

The Centers would coordinate the establishment of standards for data quality and uniformity, including standard formats for recording, archiving, and exchanging data. Working closely with data generators and higher levels of management, and based on ocean pollution program priorities and best use of available resources, each Center would decide what data are needed and what should be collected to satisfy the needs, and what data should be the subject of referral. Project management information would be submitted by the data generators to both the central referral organization and the Subject Area Data/Information Centers.

Implementation: Subject Area Data/Information Centers are likely to vary in size and their breadth of subject area coverage. Many existing data/information centers and systems could now serve as, or could be developed into, one of these centers. For example, the three NOAA/EDIS data depositories -- the National Oceanographic Data Center (NODC), the National Climatic Center (NCC), and the National Geophysical and Solar-Terrestrial Data Center (NGSDC) -- possess all, or nearly all, the required capabilities to handle marine environmental data. Several other systems -- the Coast Guard's Pollution Incident Reporting System, the Geological Survey's WATSTORE and NAWDEX systems, and EPA's STORET system -- might be used as data information centers.

C. Component: Central Coordination and Referral Office

The Central Coordination and Referral Office plays a major role in the implementation of the data and information network. This office provides a single stop service to assist the public and others in their search for data and information concerning, or resulting from, ocean pollution research and development and monitoring programs. Two primary functions of this office are:

- Referral: A central referral point is needed where the public can be supplied with or receive direction regarding ocean pollution data and information needs; and

- Management: A management role is required to direct the subordinate data and information activities, and to analyze the overall efforts.

The Central Coordination and Referral Office will refer requesters of ocean pollution data and information to the best supplier of such information, which in many cases would be the Subject Area

Data/Information Centers. The Central Coordination and Referral Office should have broad access to bibliographic material generated by marine pollution programs, and to all marine literature regardless of discipline. The office should have access to inventories of ocean-related environmental data resources, generally by automated systems, and should have its own automated files for purposes of referral.

In addition to directing the daily operations of the data network, the Central Coordination and Referral Office should develop data and information flow guidelines for subordinate levels of the system. This function is a most important requirement of the office, because without it an effective and efficient flow of data and information cannot occur.

The Central Coordination and Referral Office should have, or have access to, a modest staff (perhaps through the Subject Area Data/Information Centers or by contract) capable of performing analyses of all marine pollution programs; for example, trend analyses, financial analyses, etc. The analyses could be of a management or scientific nature, and generally would be multidisciplinary in character.

Implementation: The Central Coordination and Referral Office, because it is the most visible and perhaps the single most important component of the proposed data and information network, should receive priority consideration in any implementation plan. The activities of this Office to a certain degree exist today. For instance, NOAA's National Oceanographic Data Center or the Geological Survey's Office of Water Data Coordination could perform all or part of the requirements of the Central Coordination and Referral Office with adequate additional resources.

Many of the tools to be used by the Central Coordination and Referral Office exist. Automated access systems to bibliographic and environmental data sources are available, as are information storage and retrieval programs for the office's own use. However, a major deficiency is the lack of a proper management analysis system for evaluating ocean pollution research and development and monitoring activities. A new system could be developed, or an existing one such as the Department of Agriculture's CRIS, EPA's ORDIS, or an existing NOAA system, could be adapted to monitor data such as fiscal and manpower resources, project descriptions, and geographical distribution of programs.

Steps in the development of an ocean pollution Management Information System (MIS) should include the following:

- Develop an overall systems concept for the MIS,
- Evaluate presently available data input sources (including the presently used questionnaire),
- Evaluate available hardware and software systems,
- Develop interfacing software between input sources and the selected hardware system, and

- Test the system with FY 1978 data before operational use.

A regular schedule of program-related data collection should be followed whereby the MIS would be kept up to date. The system should have as one of its operating characteristics, beyond use of data entry and extensive analytical software, the capability to be remotely accessed by agencies involved in planning ocean pollution programs.

D. Component: Depository

All hardcopy materials generated by investigators, other observational entities, Subject Area Data/Information Centers, and the Central Coordination and Referral Office must be sent to a central designated depository. The depository must provide two important functions: it must serve as the major storage area for hardcopy materials, and it must be the single source from which all hardcopy materials are obtained. Examples of hardcopy materials are technical reports, journal article reprints, bibliographies, abstracts, documents generated from the raw data collected by investigators, and project descriptions prepared by Subject Area Data/Information Centers and the Central Coordination and Referral Office. Some kinds of digital data might be made available through the depository. It is recommended that the National Technical Information Service (NTIS) — see section II.B.2.b. — be designated as the depository. NTIS is presently operational and is capable of providing all services outlined above. Through NTIS, available materials are publicized and sold for a nominal fee.

APPENDIX -- Abbreviations and Acronyms

AAEDC--American Agricultural Economics Documentation Center
ADP--Automatic Data Processing
AG ECON--Agricultural Economics--AGRICOLA subtitle (DOA)
AGRICOLA--Agricultural On Line Access (DOA)
AGRIS--Agriculture Information System (FAO)
APHIS--Animal and Plant Health Inspection Service (DOA)
ASFA--Aquatic Sciences and Fisheries Abstracts (UN/FAO)
ASFIS--Aquatic Sciences and Fisheries Information System (UN/FAO)

BLM--Bureau of Land Management (DOI)
BOM--Bureau of Mines (DOI)

CALS--Current Awareness Literature Service (DOA/SEA)
CEAS--Center for Environmental Assessment Services (NOAA/EDIS)
CEQ--Council on Environmental Quality
CRIS--Current Research Information System (DOA)

DBMS--System 2000 Data Base Management System (DOA/ESCS)
DDC--Defense Documentation Center (DOD)
DOC--Department of Commerce
DOD--Department of Defense
DOE--Department of Energy
DOI--Department of the Interior
DOMES--Deep Ocean Mining Environmental Study (NOAA)
DOT--Department of Transportation

EDB--Energy Information Data Base (DOE)
EDBD--Environmental Data Base Directory (NOAA/NODC)
EDIS--Environmental Data and Information Service (NOAA)
EMIC--Environmental Mutagen Information Center (DOE)
ENDIX--Environmental Data Index (NOAA/NODC)
EPA--Environmental Protection Agency
ERDA--former Energy Research and Development Administration
ESCS--Economics, Statistics, and Cooperative Service (DOA)
ESIC--Environmental Science Information Center (NOAA/EDIS)
ETIC--Environmental Teratology Information Center (DOE)

FAMULUS--a software system (DOA/SEA)
FAO--Food and Agriculture Organization (UN)
FNIC--Food and Nutrition Information Center (DOA)
FWS--Fish and Wildlife Service (DOI)
FYDP--Five-Year Defense Plan (DOD)

HCRS--Heritage Conservation and Recreation Service (DOI)
HEW--Department of Health, Education, and Welfare

IDOE--International Decade of Ocean Exploration (NSF)
IGOSS--Integrated Global Ocean Station System (UN)
IOC--Intergovernmental Oceanographic Commission (UN)

MAPMOPP--Marine Pollution Monitoring Pilot Project (UN/IOC)
MEDLARS--Medical Literature Analysis and Retrieval System (NIH/NLM)
MESA--Marine EcoSystems Analysis Program (NOAA)
MIS--Management Information System
MISTIC--Model Interstate Scientific and Technical Information Clearinghouse (National Conference of State Legislatures)

NASA--National Aeronautics and Space Administration
NASQAN--National Stream Quality Accounting Network (USGS)
NAWDEX--National Water Data Exchange (USGS)
NCC--National Climatic Center (NOAA/EDIS)
NGSDC--National Geophysical and Solar-Terrestrial Data Center (NOAA/EDIS)
NIH--National Institutes of Health
NIMSCO--NODC Index for Instrumented-Measured Subsurface Current Observations (NOAA)
NIOSH--National Institute of Occupational Safety and Health (NIH)
NLM--National Library of Medicine (HEW/NIH)
NOAA--National Oceanic and Atmospheric Administration (DOC)
NODC--National Oceanographic Data Center (NOAA/EDIS)
NPS--National Park Service (DOI)
NSF--National Science Foundation
NTIS--National Technical Information Service (DOC)

OCS--Outer Continental Shelf
OCSEAP--Outer Continental Shelf Environmental Assessment Program (NOAA)
ORDIS--Office of Research and Development Information System (EPA)
OWRT--Office of Water Research and Technology (DOI)

PIRS--Pollution Incident Reporting System (USCG)
PTS--Project Tracking System (EPA)

RCIC--Regional Coastal Information Centers (NOAA/EDIS)
RECON--an interactive online retrieval system (DOE)
RIMS--Research Information Management System (BOB)
RIP--Research in Progress (DOE file)
ROSCOP--Report of Observations/Samples Collected by Oceanographic Programs (IOC)
RTECS--Registry of Toxic Effects of Chemical Substances (NLM)

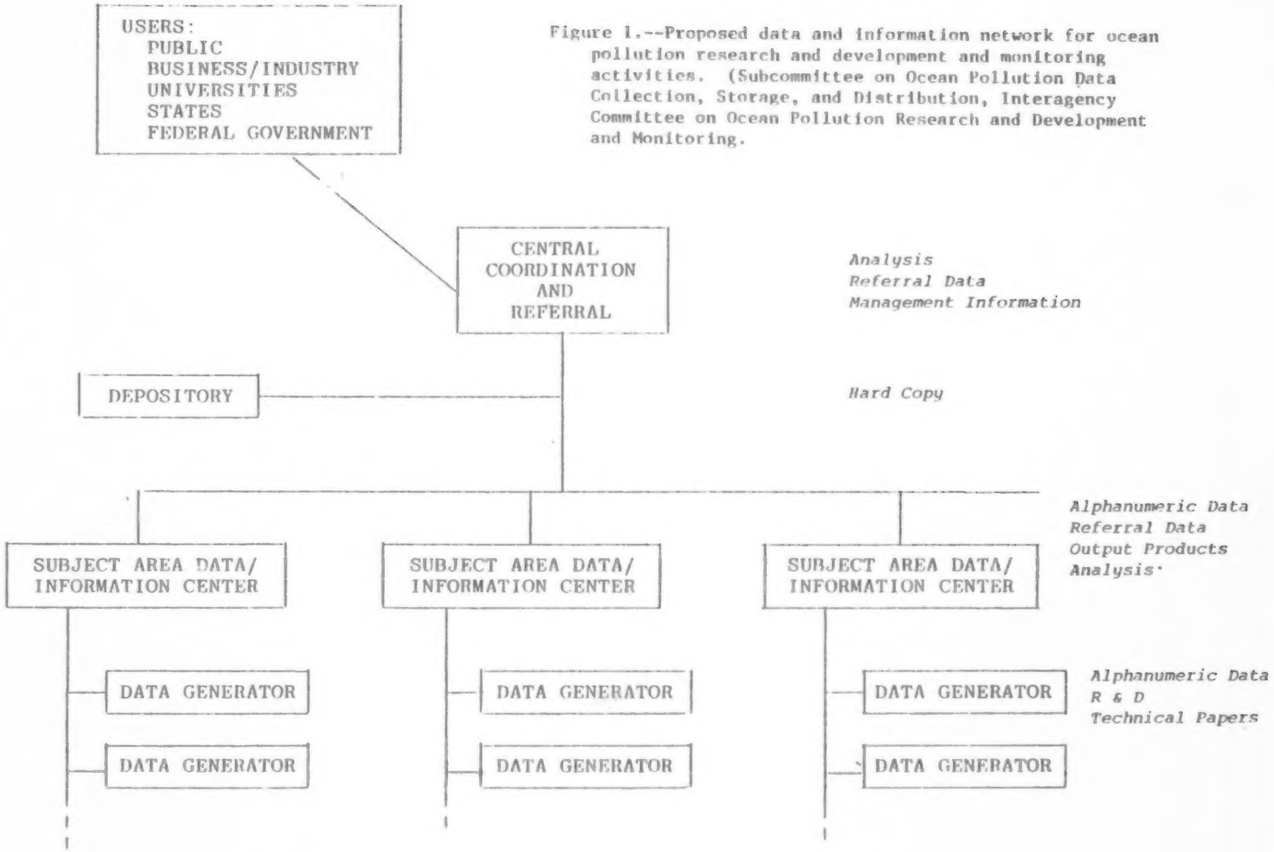
SAMANTHA--System for the Automated Management of Text for a Hierarchical Arrangement (DOA/SEA)
SEA--Science and Education Administration (DOA)
SPECTRAN--sophisticated report generating language incorporated into PIRS (USGS)
SRIM--Selected Research in Microfiche (NTIS)
SSIE--Smithsonian Science Information Exchange
STD--Salinity-Temperature-Density
STORET--Storage and retrieval data system (EPA)

TIC--Technical Information Center (DOE)
TMIC--Toxic Materials Information Center (DOE)
TOXLINE--a MEDLARS file (NLM)

UN--United Nations
USCG--U.S. Coast Guard
USDA--Department of Agriculture
USGS--U.S. Geological Service (DOI)

WATSTORE--Water data storage and retrieval system (USGS)
WMO--World Meteorological Organization (UN)
WQF--STORET Water Quality File (EPA)
WRSIC--Water Resources Scientific Information Center (DOI)

XBT--Expendable Bathythermograph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STATES
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CENTRAL COORDINATION AND REFERRAL
Analysis
Referral Data
Management Information
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Alphanumeric Data
R & D
Technical Papers

Figure 1.--Proposed data and information network for ocean pollution research and development and monitoring activities. (Subcommittee on Ocean Pollution Data Collection, Storage, and Distribution, Interagency Committee on Ocean Pollution Research and Development and Monitoring.

Report of the Subcommittee on

Ocean Pollution Monitoring

Working Paper 4
July 1979

Ferris Webster
Subcommittee Chairman

Interagency Committee on Ocean Pollution Research, Development, and Monitoring

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Federal Coordinating Council for Science, Engineering, and Technology

OCEAN POLLUTION MONITORING

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EXECUTIVE SUMMARY

This is the final report of the Subcommittee on Monitoring of the Interagency Committee on Ocean Pollution Research and Development and Monitoring. The Subcommittee was charged with: (1) identifying existing and planned Federal ocean pollution monitoring programs and activities, (2) analyzing the extent to which they meet national needs and priorities, and (3) recommending changes in the Federal ocean pollution monitoring effort in order to satisfy more fully those needs and priorities.

Definition and Purpose of Marine Pollution Monitoring

One of the first tasks undertaken by the Subcommittee was to define "marine pollution monitoring." After considerable discussion, the Subcommittee agreed that marine pollution monitoring is "the systematic, time-series observations of predetermined pollutants or pertinent components of the marine ecosystem over a length of time that is sufficient to determine the: (1) existing level, (2) trend, and (3) natural variations of the measured parameters in the water column, sediments, or biota." The basic purpose of monitoring marine waters is to obtain time-series data sets that can be used to detect significant change in the measured parameters, and to use this information to provide timely warning and other advice to management so appropriate actions may be taken.

Current Level of Effort

A major difficulty encountered by the Subcommittee was differentiation of actual monitoring efforts (as defined by the Subcommittee) from the large array of research and development and monitoring programs and activities reported by the Federal agencies. This problem was partially resolved by dividing the programs and activities into two categories: (1) monitoring programs, and (2) monitoring-related programs. The former category is defined by a strict interpretation of the definition of marine pollution monitoring. The latter category consists of research activities that either have monitoring elements in them or develop data or techniques that support existing or future monitoring efforts. The Subcommittee determined that in FY 1978 the Federal monitoring effort was funded at $17.8 million, whereas the total funding for all programs that contain elements of marine pollution monitoring, the so-called monitoring-related programs, adds up to $59 million.

Users of the Data

Users of information and data derived from marine pollution monitoring activities represent a wide spectrum of society. The greatest concern of marine pollution monitoring is to obtain information about changes to the marine environment that may be harmful to human health and/or marine ecosystems. Warnings must be issued and corrective actions have to be taken to ensure that contaminated seafood does not reach the marketplace.

Local governments, the general public, and certain industries rely on routine status reports of pollution conditions. For planning and regulatory agencies, current and accurate information on the health of ocean ecosystems is essential for good planning, for sound regulatory decisions, and for use in court proceedings. Particularly useful, but difficult to obtain, is reliable, quantitative information on trends in estuarine and ocean habitat conditions as impacted by man-induced alterations such as pollution. In international forums, the question is often raised: What is the total U.S. contribution to ocean pollution? A coordinated Federal ocean pollution effort could provide some reliable data on that issue. Finally, monitoring programs must be designed to serve as the nucleus of an early warning system to detect and, to the extent possible, permit control of the introduction of hazardous materials into the marine environment. High priority should be given to the monitoring and assessment activities required after spills of hazardous materials.

Existing Programs

The Subcommittee identified 11 Federal departments and agencies that have mandates, responsibilities, and missions for ocean pollution monitoring and/or related research. These include: Department of Agriculture (DOA), Department of Commerce (DOC), Department of Energy (DOE), Department of Health, Education, and Welfare (HEW), Department of the Interior (DOI), Department of Transportation (DOT), Environmental Protection Agency (EPA), and Nuclear Regulatory Commission (NRC). Appendix A of the report summarizes the missions and mandates of these agencies. The total expenditure for Federal marine pollution monitoring was $17.8 million in FY 1978. Of that amount, EPA accounted for over 40 percent, with $3.7 million allocated to the Great Lakes Surveillance program, $1.5 million for ocean dumping monitoring, $0.7 million for Chesapeake Bay monitoring, $0.4 million on the National Pollution Discharge Elimination System compliance, an estimated $0.6 million (of the total $11.3 million) on the direct marine part of the State and interstate agency support of monitoring activities, and $0.6 million for the last downstream monitoring station in the National Water Quality Surveillance System (NWQSS), which is managed and operated by USGS. HEW's National Shellfish Sanitation Program of HEW was funded at $2.3 million. Under this program, intermittent compilation of closures and openings of shellfish waters in the National Shellfish Register of Classified Estuarine Waters -- at an estimated cost of $60,000-75,000 per compilation -- provides a very useful national quantitative measure of the status of estuarine habitat as affected by pollution. HEW spent another $0.8 million to monitor pesticides and metals in fish. DOI funded $2.7 million through Bureau of Land Reclamation for monitoring portions of the Outer Continental Shelf Environmental Studies Program, an estimated $2.1 million through USGS to support the last downstream station in the National Stream Quality Accounting Network (NASQUAN), and $0.8 through Fish and Wildlife Service for marine monitoring activities. The National Oceanic and Atmospheric Administration (DOC) accounted for $0.6 million, most of which was directed at monitoring in the Middle Atlantic Bight.

The Subcommittee found that relatively few Federal programs are conducted only to monitor pollution. Many of the programs have a finite life span, and many are site specific and of short duration. These do not provide the long-term data base needed to monitor the marine environment. The inventory of Federal programs relating to ocean pollution includes research and projects designed to monitor specific conditions and activities. In many of these it is difficult to identify program elements specifically relating to monitoring. An example is the NOAA New York Bight Project. This interdisciplinary research effort to understand the ecosystem of the Bight includes a planning objective to develop a feasible monitoring scheme. Thus, project funds are dedicated to monitoring, but are not identified as funded for monitoring. The problem is similar to NASA's satellite and the Army Corps of Engineers R&D programs. Also, major Federal freshwater monitoring programs, such as the EPA-funded NWQSS and the USGS-funded NASQUAN, do not monitor pollutant levels or effects in marine estuarine waters, but do monitor significant inputs of pollutants to marine waters from the Nation's streams and rivers. This monitoring of freshwater sources of pollutants contributes to the marine pollution monitoring effort, but it is difficult to identify the proportion of the funding that is applicable. The Subcommittee estimated $59 million as the total Federal funding for all marine pollution-related programs and activities. This funding does not include vessel support for monitoring or monitoring-related activities. Appendix B of the report summarizes Federal funding for monitoring and monitoring-related projects in FY 1978, 79, and 80.

International marine pollution monitoring programs are in various stages of development and could benefit from increased U.S. leadership. Progress with such programs has suffered, because Member States have made inadequate commitments of resources needed to implement them. Improved U.S. foreign assistance would help meet objectives of international programs that can be viewed as extensions of U.S. domestic efforts. International sponsoring organizations include the International Council for Exploration of the Sea, International Atomic Energy Agency, the Intergovernmental Oceanographic Commission of UNESCO, and United Nations Environment Program.

Analysis

In its review of Federal activities in marine pollution monitoring, the Subcommittee divided the activities into four basic categories. These are: (1) surveillance of pollutant inputs, (2) monitoring of the ecosystem, (3) monitoring of food resources, and (4) monitoring of spills. The Subcommittee examined for each category: the scientific and management questions addressed, the agencies carrying it out, the associated needs and problems, and users of the information. Review and analysis of the Federal monitoring efforts indicate that with the exception of an adequate concern for the long-term, chronic effects of coastal marine pollution, the present monitoring efforts respond to many of the most critical needs.

The deficiencies identified by the Subcommittee in its review of the four monitoring categories are: (1) the present effort is fragmented, and with that goes a presumption that duplications as well as gaps exist; (2) the present effort is reactive rather than anticipatory; (3) the current emphasis is on local problems -- a regional focus is lacking; (4) monitoring efforts are independent of each other, with little exchange of information, technology, and data; (5) information is not readily available on all Federal and non-Federal marine pollution monitoring; (6) monitoring activities are generally site specific or pollutant specific; (7) an overall (national) rationale and strategy for monitoring is often lacking; (8) instrumentation development is lagging behind ocean pollution monitoring needs; and (9) national standards of accuracy are lacking for data-collection and analysis methodology, which diminishes the usefulness of the data.

Conclusions and Recommendations

The Subcommittee on Monitoring concluded that, to meet the requirements of the National Ocean Pollution Research and Development and Monitoring Planning Act, it is necessary to establish a program incorporating all private, local, State, and Federal ocean monitoring activities. The proposed National Ocean Pollution Monitoring Program would have the following two goals:

> Provide information necessary to assess the health of the U.S. coastal and Great Lakes ecosystems on a continuing basis; and
>
> Provide information necessary to ensure present and future protection of human health, and the safe use and wise management of the U.S. coastal marine and Great Lakes resources.

The National Ocean Pollution Monitoring Program would encompass the four categories of pollution monitoring discussed previously, and a new category, the Regional Ecosystem Monitoring programs. The five categories are:

- Surveillance of pollutant inputs,
- Monitoring of marine ecosystems,
- Monitoring of food resources,
- Monitoring of hazardous materials spills, and
- Monitoring regional ecosystems.

The Program would be implemented by designating a Federal agency to be responsible for its management and for providing staff for a management group. An interagency steering group would be formed to help establish and implement the national program, and to provide advice and interagency coordination. Major tasks of the Program would include:

- Assemble an inventory of private industry, local, State, and Federal programs of ocean pollution monitoring.
- Designate coastal regions and develop and coordinate regional coastal monitoring plans by these regions, including the designation of the responsible lead agency. The regions included are: Great Lakes, northeast Atlantic coast, southeast Atlantic coast, Gulf of Mexico coast, southwest Pacific coast, northwest Pacific coast, and Alaska.
- Establish regional and national monitoring data banks, and develop mechanisms to convert data into management use information. The data management aspects of marine pollution monitoring will be addressed by or incorporated into the plan for section 8 of Public Law 95-273.
- Define regional marine pollution monitoring needs (those that are not already being met by existing programs) and implement new programs of marine pollution monitoring in the critical regions.
- Implement the National Ocean Pollution Program in two phases: First, establish all monitoring and coordination functions of existing programs, including data and information distribution and the development of a regional monitoring plan. Second, implement new regional ecosystem monitoring programs that will use all information from existing programs and resources.

Regional Ecosystem Monitoring Program

This Program is one component of the National Ocean Pollution Monitoring Program that is specific for given regions. Basically, it is designed to fill the needs for long-term pollution assessment and surveillance in the regions. This would address two of the major deficiencies in the current programs: (1) lack of long-term monitoring of chronic effects and (2) lack of regional focus. Implementation of the program will depend on the following criteria:

- Degree of pollutant stress in the region;
- State of local concern and support;
- Availability of pollution-related research knowledge in the given area;
- Contributing programs (local, State, and Federal); and
- Priority of the local concern viewed from a national perspective.

The Subcommittee recommends that federally funded and managed programs of coastal and Great Lakes pollution monitoring be established for each highly stressed region of the United States. It also recommends that detailed monitoring plans be developed regionally and that Federal agencies and States establish coordinated monitoring programs for specific coastal regions and discrete bodies of water. Coordinated regional plans and new monitoring activities under the National Program should be implemented in FY 1981.

The Subcommittee concluded that the greatest concerns about pollution and, consequently, most support for pollution-related research and monitoring activities exist along the northeast Atlantic coast, in the Great Lakes region, and along the California coast. In California, local and State organizations have extensive monitoring activities; in the northeast Atlantic coast and Great Lakes regions there is a more concentrated Federal involvement in pollution-related research and monitoring efforts. The present annual budget from local, State, Federal, and Canadian sources for pollution-related research and monitoring activities in the Great Lakes exceeds $8 million, about half of which is Federal support. The combined local, State, and Federal budget for these activities in the northeast Atlantic coast exceeds $13 million, and again more than half represents Federal support. Because of the critical pollutant stress conditions, public and institutional support, and the existence of a sufficiently complete research base, the new monitoring efforts should be initially in the northeast Atlantic coast and Great Lakes region.

I. INTRODUCTION

A. The Ocean Pollution Planning Act

In spring 1978, Congress enacted the National Ocean Pollution Research and Development and Monitoring Planning Act (Public Law 95-273). In reviewing the importance of the coastal and offshore oceans to national well-being, the Congress found that the United States increasingly will be forced to rely on ocean resources. This increased use of the marine environment and its resources can have a profound short-term and long-term impact on the ability of the ocean and coastal systems to provide the needed resources. The ability to use the oceans wisely depends directly on the knowledge decisionmakers have about pollution-related consequences of such activities. Unfortunately, while the Federal Government supports and undertakes extensive ocean pollution research, development, and monitoring that can yield such knowledge, these activities often are uncoordinated and result in potential duplication. The Congress concluded that there was a need to develop a comprehensive Federal Plan that would better identify the needs for ocean pollution research, development, and monitoring and demonstrate how the Federal effort was organized to meet these needs in a timely and efficient way. The overall goal of the Plan is to better assure that the Federal program for research, development, and monitoring provides the knowledge needed to make better decisions on ocean use activities that may cause pollution.

Public Law 95-273, the "National Ocean Pollution Research and Development and Monitoring Planning Act of 1978," has three basic purposes:

1. Establish a comprehensive 5-year Plan for Federal ocean pollution research and development and monitoring programs in order to provide planning for, coordination of, and dissemination of information on such programs within the Federal Government;

2. Develop the necessary base of information to support, and to provide for, the rational, efficient, and equitable use, conservation, and development of ocean and coastal resources; and

3. Designate the National Oceanic and Atmospheric Administration (NOAA) as the lead Federal agency for preparing the plan referred to in paragraph (1) and to require NOAA to carry out a comprehensive program of ocean pollution research and development and monitoring under the plan.

Section 4 of this Act specifies in detail the elements that the "comprehensive Federal Plan relating to ocean pollution" should contain. The key elements within this section are:

1. Assessment and ordering of national needs and problems. Within this area, priorities for the national needs and problems must be established, and, if these priorities should change in subsequent revisions of the Plan, a detailed explanation should be given.

2. Assessment of the existing Federal capability. This should include (a) a detailed listing of all existing Federal programs including a catalog of Federal personnel, facilities, vessels, and other equipment, and detailed description of existing goals and costs of the program, including a categorical breakdown; and (b) an analysis showing how the programs will meet the national priorities.

3. Policy recommendations. These may include, but are not limited to, (a) changes in the goals; (b) suggested increases or decreases of funding; (c) proposals for interagency cooperation, including pooling of resources; and (d) suggested legislation.

4. Budget review. This should contain a description of actions to indicate how interagency cooperation and coordination are accomplished.

B. Organization of the Effort

The approach to implement the legislation has been to involve to the maximum extent possible all concerned Federal departments and agencies in the development of the 5-year Plan. In June 1978 the Director of the President's Office of Science and Technology Policy chartered the Interagency Committee on Ocean Pollution Research and Development and Monitoring (COPRDM) under the aegis of the Federal Coordinating Council for Science, Engineering, and Technology.

The Interagency Committee, chaired by the Deputy Administrator of NOAA, with EPA's Assistant Administrator for Research and Development as Vice Chairman, is made up of policy-level representatives from the Federal agencies and departments that have programs relating to ocean pollution and a representative from the Office of Management and Budget. The departments and agencies represented are:

- Council on Environmental Quality (CEQ)
- Department of Agriculture (DOA)
- Department of Commerce (DOC)
- Department of Defense (DOD)
- Department of Energy (DOE)
- Department of Health, Education, and Welfare (HEW)
- Department of the Interior (DOI)
- Department of Transportation (DOT)
- Environmental Protection Agency (EPA)
- National Aeronautics and Space Administration (NASA)

- National Science Foundation (NSF)
- Nuclear Regulatory Commission (NRC)

The Interagency Committee formed four working subcommittees to develop specific portions of, and make recommendations for, the comprehensive 5-year Federal Plan. The subcommittees are:

National Needs and Problems -- responsible for developing the statement of national needs and problems that forms the cornerstone for policy recommendations regarding changes in the overall Federal effort during the 5-year Plan period of FY 1979 through FY 1983.

Research and Development -- responsible for identifying all existing Federal research programs and facilities related to ocean pollution in order to analyze the extent to which the present programs meet national priorities, and to make recommendations to the parent committee regarding changes necessary to satisfy those priorities more fully.

Monitoring -- responsible for identification and analysis of Federal monitoring programs in a manner similar to the role of the Research and Development Subcommittee.

Data -- responsible for analyzing the current Federal capability to respond to the requirements of Section 8 of the Act.

The working Subcommittees comprise members designated by members of the parent committee to assure broad participation in the substantive program and policy analysis work. The task of each subcommittee is to prepare a comprehensive report on its respective area. This document is the final report of the Interagency Subcommittee on Monitoring.

The purpose of this report is to review and analyze the existing Federal marine pollution monitoring effort; evaluate the adequacy of this effort in meeting national needs and problems, as these are seen from the point of view of these agencies; and formulate a national ocean pollution monitoring program based on:

1. National needs, problems, and priorities identified by the interagency COPRDM;
2. Agency authorities to monitor ocean pollution;
3. Agencies' current and planned programs; and
4. Information requirements sufficient to determine quality and trends in marine environment.

C. Definition of Basic Terms

To address the subject of marine pollution monitoring, it was first necessary to establish a common base of references. This required careful definition of basic terms. The following definitions and considerations were used in the preparation of this document.

Marine Pollution. Marine pollution is a condition brought about directly or indirectly by human activities in the marine environment (including estuarine waters and the Great Lakes) that may result in hazard to human health, harm to living resources and ecosystems, hindrance to fishing and other marine activities, impairment of quality for use of seawater, and reduction of recreational and aesthetic amenities.

Marine Pollution Monitoring. Marine pollution monitoring is the continual systematic, time-series observation of predetermined pollutants or pertinent components of the marine ecosystem over a period sufficient to determine the (1) existing level, (2) trend, and (3) natural variations of measured components in the water column, sediments, or biota.

Purposes for Monitoring Marine Pollution. The basic, overriding purpose for monitoring marine pollution is to obtain time-series data sets that can be used to detect significant change in the environment, and to use this information to provide timely warning and other advice to management so appropriate actions may be taken.

Specific uses of monitoring data that may vary depending on the monitoring requirement are:

- Establish input levels and dispersion characteristics of pollutants.
- Assess safety of fish and shellfish for human consumption.
- Assess water quality to determine potential hazards to human health and the marine biota.
- Provide surveillance on the effects and fates of pollutants on selected components of the ecosystem.
- Assess the effectiveness of measures taken to reduce marine pollution.

Marine Pollution Research. Marine pollution research involves the collection of data for the determination of abundance, concentration, and distribution of pollutants (and any other components of the ecosystem, provided these determinations are part of a marine pollution-related program), their dynamics, effects, fates, pathways, processes, and causal relationships to obtain fundamental understanding, a baseline, or practical applications relative to these phenomena.

Marine Pollution Monitoring Versus Marine Pollution Research. Marine pollution monitoring and research are mutually supportive. Monitoring, i.e., systematic, time-series observations of phenomena to determine their existing level, trend, and natural variations, may be part of a research strategy. On the other hand, to initiate operational monitoring, research programs are needed to determine what components of the ecosystem or what pollutants should be observed, what should be the frequency of observations, how long a phenomenon should be observed and in what area, and how the observations should be interpreted.

Where extensive research information exists in an area, monitoring program design is benefited, yielding more cost-effective strategies, greater selectivity of sensitive parameters, and realistic spatial and temporal sampling schemes. Where extensive monitoring precedes research, monitoring information suggests good working hypotheses regarding cause-and-effect relations that can be tested by follow-on research programs.

For the purposes of this report, marine pollution monitoring implies operational monitoring and does not encompass programs composed primarily of basic environmental research. Activities that are motivated primarily by research needs, but are precursors or in some other way directly related to monitoring, are classified separately in this report as monitoring-related programs.

II. USERS OF MARINE MONITORING INFORMATION

Users of information generated by the Federal monitoring effort range from the Federal agencies, which are responsible for implementing specific legislative mandates affecting the Nation (e.g., the National Pollution Discharge Elimination System of Public Law 92-500), to individual municipalities concerned with safe swimming waters.

The needs of users of monitoring information are presented in the context of user groups and the primary needs of these groups. Table 1 provides an overview of user needs.

The highest concern of marine pollution monitoring is to obtain information about changes to the marine environment that may be harmful to human health or to marine ecosystems. Warnings and corrective actions must be taken to ensure that toxic products and poisonous fish and shellfish do not reach the market place. These warnings must be both timely and accurate. For local governing bodies, the general public, and certain industries, routine status reports must be made on pollution conditions, such as pathogen levels, tainted seafood, unhealthy state of swimming waters, or unhealthy state of fish and shellfish stocks. These data are also needed in data repositories to establish a permanent historical record of these conditions of the marine environment. To promote a basic understanding of the marine environment, monitoring information must also be made available to scientific researchers.

For regulatory and planning organizations, the health of ocean ecosystems is extremely important. The establishment and enforcement of environmental regulations must stand the test of adjudication. Data collected by monitoring activities related to this area must hold up in court. Management also needs ocean pollution monitoring information in areas other than pollution, such as fishery management, weather prediction, and navigation.

Statistically significant parameters of mean seasonal variations must be available to management in order to evaluate the impact of proposed environmental modifications, wisely influence decisions, and provide input into ecosystem modeling.

Monitoring programs must be designed to serve as the nucleus of an early warning system to detect and, as far as possible, permit control of the introduction of hazardous materials into the marine environment. The monitoring and assessment activities required after an accidental spill of hazardous materials should be given high priority.

In planning for activities in coastal, estuarine, and Great Lakes waters, a sufficient history of past conditions must be reaily available. The present EPA programs to consider requests from coastal municipalities for relief from the secondary treatment requirements of Public Law 92-500 would be greatly enhanced with a more precise knowledge of the health of

Table 1.--Monitoring users and needs

User groups	Needs
State government	Natural resources, water quality, ecology, fish, game, public health, waste disposal - estuarine, Great Lakes, and territorial seas.
Districts, commissions, communities	Wastewater treatment planning, ocean outfalls, long-range multistate/basin planning. Section 208 (Public Law 92-500) areawide planning.
Public interest groups	Conservation foundations, national/State ecology interest groups, environmental protection.
General public	Recreational needs, aesthetic concerns, consumer health.
Federal environmental protection agencies (EPA, COE, NRC)	Water quality and contaminant compliance, ocean disposal, public health, ocean outfall setting.
Energy related	Powerplant sitings (nuclear and conventional), ocean thermal energy conversion (OTEC), deepwater ports.
Federal agencies responsible for resource management	Outer continental shelf leasing; coastal, estuarine and Great Lakes fishery management; coastal zone management; marine sanctuaries.
Pollution abatement	Detection and enforcement, compliance with permits, evidence for prosecution, load allocation.
Mineral resources extractors	Deep ocean mining; Sand and gravel extracting; Environmental assessments.
International responsibilities, obligations	*IGOSS marine pollution monitoring pilot project; **ICES pollution requirements; identification of U.S. input to ocean pollution.
Environmental research community	Data and information necessary to further understand basic ecosystem processes. Verification and adjustment of predictive models.

*IGOSS -- Integrated Global Ocean Station System.
**ICES -- International Council for the Exploration of the Sea.

the coastal ecosystems that may be affected should EPA approve the requested modifications. Likewise, the development of coastal zone management plans and designation of marine sanctuaries require a substantial data base of monitoring information.

U.S. responsibilities to international environmental organizations (either governmental or nongovernmental) require the establishment and maintenance of a National Ocean Pollution Monitoring program. The question is often raised how to determine the total U.S. contribution to the world's ocean pollution. Such an assessment cannot be made without a centrally managed, coordinated monitoring program, with its results feeding into a central location.

Public and economic interests are often seemingly in conflict in U.S. coastal waters. The monitoring program should be responsive to international commitments as well as to the immediate needs of U.S. citizens. Emphasis of a National Ocean Pollution Monitoring Program should be placed on establishing and improving services (including information, assessments, and predictions) to the users along U.S. coastal waters, estuaries, and Great Lakes.

Monitoring programs must be able to assess the short- and long-term effectiveness of habitat protection, mitigation, and enhancement measures as required under the Fishery Conservation and Management Act of 1976.

Table 2 shows agencies' responsibilities and mandates in meeting users' needs. The table has four sections based upon the main monitoring categories used throughout this report. Appendix A has a full description of each agency's specific mission and legislative mandate.

Table 2.--Users of monitoring program

Category of monitoring	Types of user groups	Agencies responsible	Authorizing activity	Product
I. Effluents and other sources of pollutants, and compliance/permit actions	Compliance monitoring and regulatory agencies	COE DOD DOE EPA NRC USDA	92-500 Sec. 402 Sec. 404 92-532 Sec. 102 Sec. 103	Issuance of violation citations, authorization of loading permits, enforcement actions, criteria development, and environmental impact statements
II. Ecosystem health and ambient water-quality	Planning and research groups, international groups, and resource use groups (e.g., municipal water supply bodies)	BLM EPA NASA NOAA NSF USCG USGS	92-500 92-532 Sec. 201 Sec. 202 FCMA CZMA	Annual reports, load allocations, development and refinement of planning a la 208, and determination of status of nonpoint-source input
III. Fish and shellfish	Market place consumers, resource assessment groups, and fishing industry	DOI EPA FDA HEW NOAA	Sampling FDA mandate National Shellfish Sanitation Program	Restricted use of areas and corrective action
IV. Hazardous materials	States, fishing industry, and public interest groups	EPA NOAA USCG Inter-agency	National Oil and Hazardous Substances Pollution Contingency Plan	Damage assessment reports and short-term effects to reduce long-term damage

III. EXISTING PROGRAMS

Various Federal agencies conduct or administer marine pollution-related research, development, and monitoring in response to their missions and mandates. These mandates may be quite specific or general. An example of the specific is Section 201 of the Marine Protection, Research, and Sanctuaries Act of 1972, which requires NOAA to engage in ocean dumping research and monitoring. Many programs are instituted under the broader requirements of laws such as the National Environmental Policy Act of 1969. Appendix A summarizes missions and mandates of 11 agencies responsible for programs related to the Federal ocean pollution research, development, and monitoring effort.

A. Monitoring Programs

In this first iteration of an inventory for marine pollution monitoring programs, several conceptual and administrative difficulties were encountered. Aside from the difficulty of finding and separating operational monitoring activities from research and development relevant to monitoring (to be discussed in the next section), a major difficulty was the demarcation between freshwater and marine monitoring. Several large national programs cover both marine and freshwater systems, such as the National Pesticide Monitoring Network for Birds (Fish and Wildlife Service, DOI), the Great Lakes Surveillance Program (EPA), the EPA National Water Quality Surveillance System (NWQSS), and the USGS National Stream Quality Accounting Network (NASQUAN). For these programs, estimates have been made to reflect that component of program funding that represents the last downstream station and marine (estuarine and Great Lakes) areas. The EPA-funded, USGS-managed and operated NWQSS comprises 188 stations nationwide that are paired to provide water quality measurements both above and below major types of local use areas. NASQUAN, on the other hand, is the main federally funded national program monitoring for stream and river water quality. This network comprises 515 stations that measure many standard water quality constituents; some stations measure for pesticides and radionuclides. This report includes the last downstream stations of both NWQSS and NASQUAN, because they provide valuable monitoring information on the vast amounts of pollutants that enter marine and estuarine waters from the Nation's network of rivers and streams.

Problems are also encountered when one attempts to categorize the EPA-funded State Monitoring Program. For example, each year EPA issues grants to State and Interstate agencies for monitoring under section 106 of the Clean Water Act, Public Law 95-217. The monitoring portion of this Federal grant is $11.3 million, which is allocated to the States based on the extent of individual pollution problems. The States, in turn, using a combination of Federal and State funds, maintain a variety of marine and freshwater monitoring activities to support several EPA (the Basic Water Monitoring Program) and State needs. These monitoring activities can vary from year to year, and some are conducted in estuaries and

Table 3.--Federal resources allocated for marine pollution monitoring programs in fiscal years 1978, 79, and 80

	Funding		
Agency and program	FY 78	FY 79	FY 80
	(Thousands of dollars)		
EPA:			
Great Lakes Program	3,728	3,728	3,728
Baseline Surveys and Monitoring of Ocean Dumping Sites	1,500	1,500	1,700
Chesapeake Programs	699	699	699
State and Interstate Agency Water Monitoring (106)	550	550	550
National Water Quality Surveillance System (NWQSS)	550	450	400
NPDES Compliance Monitoring	411	411	411
National Marine Pollution Monitoring Program (Mussel Watch)		350	350
Subtotal:	7,438		
DOC/NOAA			
Ocean Pulse		250	1,281
Microconstituents	616	1,136	1,226
Ocean Dumping	400	500	600
Northeast Coastal United States	437	301	75
Prince William Sound Hydrocarbon Monitoring	83	83	83
Chesapeake Bay	62	62	
Other	47	47	
Subtotal:	1,645		
HEW:			
National Shellfish Sanitation	2,300	2,300	2,300
Pesticides and Metals in Fish	800	800	800
Other	10	10	10
Subtotal:	3,110		
DOI/BLM			
OCS Environmental Studies	2,689	817	2,150
DOI/USGS			
National Stream Quality Accounting Network (NASQUAN)	2,100	2,100	2,100
DOI/FWS:			
National Freshwater Fish Monitoring Network - Estuaries	100	100	100
Trans-Alaska Pipeline - Port Valdez	150	150	
Sturgeon and Striped Bass in San Francisco Bay	250		
Great Lakes Surveillance	160		
National Pesticide Monitoring Network for Birds - Waterfowl	120*		
Other	62		
Subtotal:	842		
TOTAL:	17,824		

* Funded every 3 years.

marine areas. A strict accounting is not readily available for these activities; therefore, it has been estimated, for this report, that less than 5 percent ($0.55 million) of the monitoring portion of the section 106 grant is expended each year for marine/estuarine monitoring.

Table 3 shows the marine pollution monitoring programs arranged by Federal agencies. See appendix B for further breakdown.

B. Monitoring-Related Programs

Relatively few Federal programs are conducted exclusively for the purpose of marine pollution monitoring. The Federal marine pollution-related programs inventory has many research programs, however, that contain component projects designed to monitor a specific set of conditions or activity. One of the inherent problems in attempting to describe the Federal efforts in marine pollution monitoring is the difficulty in discerning which programs are relevant to monitoring. Another problem is that many programs are begun with an intent to monitor pollutants at a later time. Studies are initiated to develop methods for monitoring marine pollution or to explore the feasibility for monitoring a certain aspect of marine pollution. Whatever the overall goals and objectives of these larger comprehensive programs, they generally proceed through several developmental phases before entering either an interim or final monitoring phase. These phases may be designated as: (1) definition of the problem (describing hypothesis); (2) survey (baseline, benchmark, historical, etc.); (3) supportive research and development; (4) experimental (prototype) monitoring; (5) operational monitoring.

A good example of this type of program is the DOI Bureau of Land Management's Outer Continental Shelf (OCS) Environmental Studies. Because of the holistic nature and design of this program, monitoring components are not readily identifiable, particularly in out-year budget and planning statements. In some cases, monitoring may not be performed, because it is usually keyed to OCS oil and gas exploration and development, which may not occur.

Programs of this nature may also undergo redefinition; i.e., the original hypothesis may be inadequate, thereby causing the program to regress to a previous phase. Further compounding our problem of program definition is that not all regional segments are in the same phase or they may be between phases. Also, initiation of one phase does not necessarily terminate the previous phase.

Other programs such as NOAA's New York Bight Project were designed and implemented toward attaining the goal of a better understanding of a particular segment of a coastal marine ecosystem. One objective of that program is to recommend a feasible monitoring scheme for the area. Programs such as these may be considered precursors to planning monitoring projects.

Programs such as NASA's satellite programs support marine pollution monitoring activities. Most of this type of effort has been categorized as developmental; consequently, it is listed under relevant research and development. Many other agencies, such as Army Corps of Engineers, EPA, and NOAA, are also funding projects for the development of new methods and instrumentation for marine pollution monitoring. A comprehensive listing of these supportive activities could not be derived with the information submitted. A further analysis of the Federal program will be necessary.

An important support activity provided by several agencies is vessel services. This effort and its funding level are not delineated in many of the programs. Even though many research programs have budgeted for this support, it is not possible to derive the level of funding allocated to monitoring. Therefore, these support activities are not fully accounted for in the budgets given in this report. However, it must be pointed out that a significant level of effort and funds is required for vessel support in order to carry out monitoring activities. The U.S. Coast Guard (DOT) provides vessel support for EPA's Ocean Dumping Program and also makes numerous surveillance patrols. NOAA provides vessel support for environmental studies on the continental shelf, some of which are monitoring.

The programs listed in table 4 illustrate the problems just discussed. This is not intended to be an exhaustive listing, but it is intended to depict the magnitude of monitoring-related activities.

In FY 1978, Federal research and development that was conducted in part to provide relevant information to monitoring amounted to $61.3 million.

Table 4.--Federal resources allocated for marine pollution monitoring-related programs in fiscal years 1978, 79, and 80

Agency and program	Funding FY 78	Funding FY 79	Funding FY 80
	(Thousands of dollars)		
DOI/BLM:			
Outer Continental Shelf Environmental Studies: (1) Lower 48 States	16,900	20,445	28,572
(2) Alaska	19,100	14,850	
DOC/NOAA:			
Marine Ecosystem Analysis	6,154	7,438	4,713
Ocean Dumping	1,906	2,361	2,964
Great Lakes	2,512	2,512	2,512
DOE:			
Strategic Petroleum Reserve (NOAA)	1,994	3,898	1,124
Ocean Thermal Energy Conversion (OTEC)	1,359	2,038	2,522
NASA:			
Technologies and Methods Development for Marine Monitoring	1,750	531	650
DOT/USCG:			
Pollution Incident Reporting System (PIRS)	200	200	200
IGOSS Marine Pollution Monitoring Pilot Project (Tarballs)	500 (for maintenance)		
Aerial Pollution Surveillance Patrols	No specific funding -- part of multimission operations		
IGOSS - Observations of Oil Slicks and Other Floating Pollutants	No specific funds		
Ocean Dumping Monitoring Assistance	No specific funds		
EPA:			
Chesapeake Bay Studies	5,000	5,000	
Environmental Assessment Northern Puget Sound and Strait of Juan de Fuca (NOAA)	850	850	
Buccaneer Oil Field (NOAA)	600	600	
TOTAL	59,825		

C. International Monitoring Programs

Efforts to design, organize, and implement marine pollution monitoring activities through multinational collaboration have been underway for several years. Such monitoring activities as well as ocean pollution research projects are fragmentary at best. The lack of a cohesive and comprehensive program within the United States is contributory to the existing fragmentary nature of the international programs.

A leading U.S. objective for international marine pollution monitoring programs is for them to serve as extensions of our pursuit of domestic objectives. There are additional objectives, of course. To realize such international program development and implementation requires significant U.S. leadership within the sponsoring international organizations. To date, such U.S. leadership has been partially effective, but requires strengthening. Full implementation of the intent of the National Ocean Pollution Research and Development and Monitoring Planning Act should provide a foundation of strength for increased U.S. leadership. Lack of resource commitments by member states involved in international organizations is the principal deterrent to progress in implementing international programs of ocean pollution monitoring. An increase in our foreign aid program to help eligible developing countries upgrade their marine science capabilities will facilitate expanded country participation in such programs. Our foreign aid programs require increases in training of foreign scientists, visits of U.S. scientists and educators to selected foreign countries, and technical assistance to upgrade vessel and laboratory facilities.

Based on a liberal interpretation of "marine pollution monitoring," several international organizations sponsor monitoring programs. Most of the activities referred to as monitoring are integral to research work during specified periods; only a small percentage of the activities actually correspond to the definition used in this report, namely "the systematic, time-series observations . . . over a period sufficient to determine . . . ." The International Council for Exploration of the Sea (ICES) has had research projects involving baseline monitoring for the longest duration. ICES activities have been confined mostly to the Baltic and North Seas and to the northeastern Atlantic Ocean; some work has been done in other adjacent waters. That monitoring effort has focused on heavy metals and organic contaminants in fish and seawater. International exchange of data collected via such programs is through international agreements reached within the ICES organization. Considerable progress has been made during the past 3 years in development of a program to monitor selected coontaminants in the Mediterranean Sea under the aegis of the United Nations Environment Program (UNEP). Additional UNEP-sponsored activities are in various stages of planning for regions such as the Caribbean Sea, Gulf of Guinea, and selected regions of the Pacific and Indian Oceans. The International Atomic Energy Agency (IAEA) also sponsors some monitoring programs that focus on radioactive substances in the marine environment. The Intergovernmental Oceanographic Commission (IOC) of UNESCO has organized and is coordinating the development of a long-term monitoring program that is focusing on marine contaminants. In 1978, a pilot project -- The Integrated Global Ocean Station System (IGOSS -- was initiated, to develop a coordinated multinational program aimed at determining the extent of petroleum hydrocarbon contamination of the world's oceans. Further consideration is being given to modification of the pilot project procedures for the purpose of converting the project to a continuous operational program that could eventually include the monitoring of additional contaminants. Scientific and technical advice is being assembled to serve as a basis for decisions on the IOC program of marine pollution monitoring. IOC is arranging to help developing countries upgrade their capabilities to participate in such programs.

IV. ANALYSIS

The projects and programs submitted to the Monitoring Subcommittee represent a mix of operational monitoring and research activities. Operational monitoring programs and relevant research programs are separated in accordance with the definitions and interpretations presented in section 1.A. This report does not consider monitoring programs that are not pollution related (e.g., basic fish stock assessments) or that are monitoring a freshwater environment (except the Great Lakes). An exception to this is the support for the last downstream stations in NWQSS (EPA) and NASQUAN (USGS). Geological and geophysical monitoring and studies of geological hazards to offshore oil-drilling platforms are included in this report when they are part of a marine pollution-related study.

Marine pollution monitoring is a broad term. It includes types of monitoring activities that differ in scope and intent. A review of Federal activities in marine pollution monitoring led to grouping the activities into the following four categories:

Surveillance of pollutant inputs for the purpose of setting guidelines and standards, checking compliance with regulations, and ensuring that dispersion characteristics and effects are within previously established limits.

Monitoring of marine ecosystems (water column, sediments, and biota) to (1) determine potential hazards to human health and marine biota, (2) assist in the development or refinement of control strategies and environmental indicators, and (3) advance research and technology for the protection of the ecosystem.

Monitoring of food resources to determine their safety for human consumption.

Monitoring of spills, i.e., the existence, fate, and dispersion of hazardous substances entering the ecosystem via spills. This does not include the operational activities related to spills, such as cleanup.

The following is a summary discussion of each of the above categories of monitoring, with brief reviews of the questions of concerns, present programs, apparent needs and problems, and user requirements for each category.

A. Surveillance of Pollutant Inputs

Most of the operational monitoring activity involves surveillance of pollutant inputs, such as operational discharges of industrial and domestic effluents, and ocean dumping.

Questions of concern addressed by this type of monitoring are:

- What is being discharged?
- What is the level, trend, and variability of the discharge?
- What is the concentration of pollutants in the discharge?
- What are the dispersion characteristics of the effluents?
- Are the established guidelines and standards being met?
- Are the existing levels found within tolerance limits?

Present monitoring efforts are made by private industries, States, and the Federal Government. The permittees monitor most operational discharges and ocean dumping activities. Permits issued for waste discharge usually only indicate the amount of waste authorized for removal rather than the actual amount discharged. This procedure makes it very difficult to identify actual amounts of materials discharged into the marine environment. EPA is responsible for monitoring pollutant inputs as part of the National Pollutant Discharge Elimination System (NPDES). Under NPDES, every discharger in the United States is licensed to remain within defined pollution limits. The discharger provides sampling and analysis of the effluent to show maintenance of their permit criteria. EPA and/or the States provide compliance monitoring to ensure the accuracy and reliability of the discharger's data. The EPA STORET system stores all NPDES data.

Needs and problems related to the present efforts to monitor pollutant inputs are:

- All the input point sources are not, and perhaps cannot be, monitored adequately;
- Nonpoint source inputs are difficult to monitor;
- Information on local/regional pollutant loads needs to be better defined; and
- Information on all the Federal and non-Federal monitoring programs and their data is not readily available.

Users of pollutant input monitoring information include all the local, State, and Federal agencies whose missions include standards, guidelines, and regulation determinations, and the enforcement of these. Information from these efforts would benefit other agencies and institutions whose missions are environmental assessment, management, and research.

B. Monitoring of Marine Ecosystems

This is a very broad area of monitoring that encompasses a significant part of the federally supported monitoring eforts and most of the research efforts related to monitoring.

Questions of concern are:

- What are the levels of concentrations of target pollutants in the water body, sediments, or biota?
- What are the long-term or areal trends of pollution, and what is the variability?
- Are the pollutant levels that exist in the environment a hazard to human health or the biota?
- What are the best indicators of the pollution present?
- What are the effects of the pollutants on living resources?
- What are the dispersion characteristics and fates of pollutants?
- What is the assimilative capacity of the ecosystem?
- What models describe best the ecosystem's response to pollutant load and natural conditions?

Present monitoring programs are conducted by individual permittees, municipalities, States, and Federal agencies. Most of the operational monitoring programs reviewed are concerned with the impacts of some target pollutant in a local ecosystem.

Needs and problems in this type of monitoring effort include:

- Long-term data base for immediate use (application) of monitoring data is often nonexistent;
- Monitoring activity is overly site specific and pollutant specific (local problem);
- Monitoring efforts are independent of each other, and there is little exchange of information, technology, and data;
- Consideration for regional pollution problems and a rationale and strategy for monitoring are often lacking;
- Research and state-of-art instrumentation lag behind monitoring program needs;
- Information on most of the Federal and non-Federal monitoring programs and their data is not readily available; and

- Development of a Federal Ocean Pollution Monitoring Program that would take a holistic view of the U.S. estuarine and coastal pollution problem is lacking.

Users of this type of monitoring information include the local governments; local, State, and Federal regulatory and environmental management agencies; research organizations; international environmental research and management bodies; and the general public.

C. Monitoring of Food Resources

Questions of concern under this monitoring activity are:

- Are viral or bacteriological microorganisms present in sea food? In what amounts?
- Are toxic metals, pesticides, etc., present in seafood? In what amounts?
- Should a given area be closed for fishing or shellfishing, because of sewage sludge dumping or other perturbations to the marine environment?

Present monitoring includes two major programs: (1) the National Shellfish Sanitation Program of FDA, including its intermittent publication of the National Shellfish Register of Classified Estuarine Waters, and (2) the Microconstituent Program of NOAA/NMFS. The Shellfish Sanitation Program is managed at the State level with FDA providing overall guidance, supervision, and assistance as requested. The NOAA Microconstituent Program is managed by the National Marine Fisheries Service and conducts research and surveys that will provide an information base on the levels and significance of hazardous materials in fish and fishery products. At present, microconstituent work, conducted at the State or Federal level, is usually done on samples purchased at either the marketplace or important fish landing facilities.

Needs and problems are:

- Need a regionally coordinated monitoring program to identify target areas for intensive monitoring of possibly contaminated food supply;
- Need to develop a program that addresses areas other than viral and bacterial contamination of shellfish;
- Program should be expanded to sample at exact problem location rather than at the market place or landing facility; and
- Program should be coordinated with an overall National Ocean Pollution Monitoring Program.

Users of this monitoring information are the local and State governments and FDA, who are responsible for ensuring that contaminated foodstuffs will not endanger public health.

D. Monitoring of Spills

This type of monitoring activity can be either short-term and concerned with the immediate ecological and human health impact of some hazardous substance spill or long-term and provide information needed to assess the recovery of impacted ecosystems after a spill event.

Questions of concern include:

- What are the dispersion rates of the spilled material?
- What are the immediate ecosystem impacts?
- Which direction is the pollutant moving?
- What areas are going to be affected?
- How readily does the impacted ecosystem recover?

Present monitoring is an interagency effort involving EPA, NOAA, and USCG. National and regional scientific response teams have been formed to respond and provide scientific and operational assistance to minimize environmental damage when accidental spills occur.

Needs and problems are:

- Monitoring requirements are unpredictable;
- Resources and manpower have to be diverted from other programs;
- Most spills occur so close to shore that impact occurs before adequate warnings can be issued;
- Often there is little or no baseline ecosystem information available for the spill area; and
- It is often difficult to obtain whatever baseline or monitoring information that has already been collected for a particular spill area.

Users of this monitoring activity include the local and State governments, local fishery organizations, and the public.

V. ADEQUACY OF FEDERAL MONITORING EFFORTS

The review and analysis of the Federal monitoring efforts indicate that the present monitoring efforts respond to the most critical needs, with the exception of an adequate concern for the long-term, chronic, sublethal effects of pollution of the Nation's coastal waters, The combined monitoring efforts of private industry and Federal, State, and local governments assure that the general public is protected from health hazards caused by the consumption of contaminated seafood products and exposure to polluted swimming areas. The monitoring of spills of hazardous materials in coastal waters is accomplished through an interagency team, primarily managed by the Coast Guard, EPA, and NOAA.

Although there are programs for effluent monitoring, beach surveillance, shellfish monitoring, and monitoring of the dumping and accidental spills of hazardous materials, most of these efforts are in areas where the problems already have been identified, and are oriented toward some specific local concerns. Many areas of the country that are removed from obvious polluting activities are not being actively monitored for pollutants. Monitoring in these areas usually ensues after a deleterious event or activity has been identified. This is a crisis response philosophy; the approach should be one of prevention. A large part of prevention is, of course, source control, but a systematic, regional monitoring program of the coastal ecosystem should be able to alert State and Federal agencies to potentially dangerous pollution situations before they actually occur.

It is essential to have private industry, local, State, and Federal agencies involved in a cooperative program of marine pollution monitoring. Each has specific needs and concerns with varying perspectives. The key problem is that often their efforts are conducted without the knowledge of one another, and data and information are not readily available to share among potentially interested managers. It is clear to the Monitoring Subcommittee that there is a need to establish a "National Ocean Pollution Monitoring Program" that would collect all pertinent information on pollution monitoring from all sources, would assure that this information is converted into "management use" products, would coordinate pollution monitoring efforts, and would develop regional programs for pollution monitoring to help ensure that all coastal area ecosystems are safe from quality deterioration.

Other inadequacies that hamper marine pollution monitoring programs are: (1) the lack of tested monitoring technology using indicator organisms; (2) lack of usage of standard methods in data collection, recording format, and analysis for toxic materials in marine water and biota, which are needed to assure quality and comparability of data and to improve their usefulness to resource managers and in litigation proceedings; and (3) lack of improvements in instrumentation needed to initiate large-scale, cost-effective monitoring programs.

VI. A NATIONAL OCEAN POLLUTION MONITORING PROGRAM

Exact figures are not available on the funds spent by private industry, and local and State governments, on various aspects of marine pollution monitoring, but it is estimated that these exceed the funds spent by Federal Government programs on operational monitoring of marine pollution. These programs respond to local needs and requirements, and the programs themselves and their data remain largely unknown to management concerned with regional and national needs. The current efforts on Federal marine pollution monitoring are distributed among several departments and agencies; these efforts are carried out to support the missions and mandates of those organizations. Because of the fragmentation of these individually important efforts, a truly national perspective of the pollution monitoring requirements of our estuarine and coastal waters has not been established. The Committee believes that the establishment of a National Ocean Pollution Monitoring Program, incorporating all private, local, State, and Federal efforts, would help focus and improve the Federal Government's ability to ensure the wise management and protection of our estuarine and coastal marine resources.

To justify the establishment of a National Ocean Pollution Monitoring Program it is important to define a strategy for ocean pollution monitoring. The basic question of "Why monitor?" must be answered. Careful consideration must be given to site selection, and the basis for becoming involved in a particular geographical region must be stated. Goals and objectives must be stated, and these must be achievable within present technological and resource constraints. Additionally, the program components, products, and implementation strategy must be outlined. A framework should be created for the identification of specific pollutants to be monitored with emphasis placed upon stressed ecosystems. Significant logistical problems must be identified. A suggested framework for developing the National Program follows.

A. Goals and Objectives

Recommended goals of the National Marine Pollution Monitoring Program are:

- Maintain an assessment of the health of the U.S. coastal* marine ecosystem.
- Provide information necessary to ensure present and future protection of human health and the safety and wise management of U.S. coastal marine resources.

Objectives that must be satisfied to meet the goals of the National Marine Pollution Monitoring Program are:

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*Note: "Coastal includes estuarine, Great Lakes, and nearshore ocean waters seaward to the extent of significant pollutant impacts.

- Determine the existing levels, trends, and natural variations of contaminants and their toxic breakdown and bioconversion products in the water column, sediments, and biota.

- Establish and maintain a historical record of marine pollution monitoring programs, their data, and other pertinent information.

- Provide relevant information in a timely manner for planning and management to regulatory organizations and the general public.

- Determine the effects of specific human actions on the coastal marine environment and on its resources.

- Detect and provide an early warning of significant changes in the coastal marine environment and its resources.

B. Components and Products

The National Ocean Pollution Monitoring Program should encompass the previously discussed four components of pollution monitoring and a new component, Regional Ecosystem Monitoring. The five components are:

- Surveillance of pollutant inputs;

- Monitoring of marine ecosystems;

- Monitoring of food resources;

- Monitoring of hazardous materials spills; and

- Monitoring of regional ecosystems.

Products and services provided by the National Ocean Pollution Monitoring Program should be useful to local, State, and Federal management groups that are concerned with the state of the marine environment. These products include:

- Current inventory of private industry, local, State, and Federal program of ocean pollution monitoring.

- Regional and national depositories for marine pollution monitoring data.

- Frequent technical reports on management issues related to marine pollution.

- Ad hoc reports on environmental consequences of major spills or potential pollution crises, and other pollution-related information on an "as-needed" basis.

- Annual reports on the state of the coastal marine ecosystem, its resources, and the status of the National Program.

C. Strategy for Program Implementation

In implementing the program the following actions should be considered:

- Designate a Federal Agency to be responsible for the management of the National Program, and provide staff for a management group.
- Establish an interagency steering group to help establish and implement the National Program, and to provide advice and interagency coordination to the established program.
- Assemble an inventory of private industry, local, State, and Federal programs of ocean pollution monitoring.
- Designate coastal regions and develop and coordinate regional coastal monitoring plans by these regions, including the designation of the responsible lead agency. The regions proposed are: Great Lakes, northeast Atlantic coast, southeast Atlantic coast, Gulf of Mexico coast, southwest Pacific coast, northwest Pacific coast, and Alaska coast.
- Establish regional and national monitoring data banks, and develop mechanisms to convert data into management use information.
- Define regional marine pollution monitoring needs (those that are not already being met by existing programs), and implement new marine pollution monitoring programs in the critical regions (regional ecosystem monitoring).
- Implement the National Ocean Pollution Program in two phases: First, coordinate all assessment and management functions of the existing programs, including distribution of data and information, and planning for regional monitoring; second, implement new regional programs of ecosystem monitoring that will use all information from existing programs and resources.

D. Regional Program of Ecosystem Monitoring

This component of the National Ocean Pollution Monitoring Program is specific for a given region. Basically, it is designed to fill the long-term needs for pollution assessment and surveillance of a particular region. Development of the program should be based on the following criteria:

- Degree of pollutant stress in the region;
- State of local concern and support;

- o Availability of knowledge on pollution-related research in the given area; and
- o Contributing programs (local, State, and Federal).

To implement a regional Ecosystem Monitoring Program, the following phases are required:

1. Assess existing programs and data;
2. Collect supplementary information in the field (research);
3. Design and test a monitoring strategy; and
4. Implement operational monitoring (Regional Ecosystem Monitoring).

Activities indicated in the first three phases are necessary to define the existing ecosystem and pollution conditions as background, establish relations among components of the ecosystem and the pollutants, and define an operational monitoring strategy.

The identification, evaluation, and status of each phase in the seven previously defined coastal regions are as follows:

Area	Phase 1	Phase 2	Phase 3	Phase 4
Great Lakes	X	X	X	X?
Northeast Atlantic coast	X	X	X	
Southeast Atlantic coast	X			
Gulf of Mexico coast	X	X?		
Southwest Pacific coast	X	X	X?	
Northwest Pacific coast	X	X		
Alaska coast	X	X		

X = phase substantially complete; X? = phase partially complete; and blank = phase not implemented.

Our analysis indicates that the greatest concerns about pollution and, consequently, most support for pollution-related research and monitoring activities exist along the northeast Atlantic coast, in the Great Lakes region, and along the California coast. In California, local and State organizations carry on extensive monitoring; in the northeast

Atlantic and Great Lakes regions, the Federal Government is more involved in pollution-related research and monitoring efforts. The present annual budget from local, State, Federal, and Canadian sources for pollution-related research and monitoring activities in the Great Lakes exceeds $8 million, about half of which is Federal support. The combined local, State, and Federal budget for these activities in the northeast Atlantic region exceeds $13 million; again more than half represents Federal support.

This effort indicates the recognition of the problems in these regions. The following briefly highlights the problems and concerns.

In the Great Lakes region the causes for the deterioration of water quality include eutrophication, caused by phosphorus from land runoff and atmospheric fallout; sediments from erosion, dredging, and watershed runoff; pesticides, heavy metals, industrial organics, and PCB's, often carried together with sediments; and bacteria and viruses from combined sewer overflows.

In the northeast Atlantic region the concentrations of industries and urban populations around the New York Bight already have had serious effects on the ecosystem. Almost all estuarine areas of the New York Bight Apex are closed to shellfishing; bathing is prohibited in all but Lower and Jamaica Bays; and, in large areas, fishing is not allowed. Water quality fails to meet the New York State standards, often by wide margins. Total coliform levels have caused the closing of many Bronx, Coney Island, Jamaica Bay, and Staten Island beaches in the past, as have the strandings of floatable debris, grease balls, tar balls, and oil entering the harbor from combined sewer overflows, urban runoff, and other sources. Almost all shellfish-producing areas in the Hudson-Raritan Estuary have been closed, because of bacterial contamination, and shellfish from many other areas have been rendered unfit for consumption, because of contamination from chemicals or oils.

Major concerns in the Chesapeake Bay include impact of carbon and nutrients from sewage-related materials released in the estuaries and from land runoff containing fertilizers; the impact of toxic substances (PCB's and Kepone); the impact of refined and crude petroleum products; and the impact of disease-causing agents such as viruses and bacteria.

These serious pollution problems, the concentrated local, State, and Federal commitment and the advanced state of related research in the areas, suggest that regional operational monitoring programs should be implemented first in the Great Lakes and northeast Atlantic regions.

E. Monitoring Strategy

Strategy involves the selection of (a) critical conditions to be monitored, (b) distribution of sampling stations, and (c) sampling frequency. Based on the experience gained from ongoing studies, four approaches to monitoring are considered:

1. Measurement of independent variables, such as water temperature, color, PCBs, and mercury levels;

2. Measurement of influencing factors, such as currents, winds, and estuarine inflow;

3. Measurement of effects, such as diseased fish and change in population structure; and

4. Measurement of response indicators, such as bioaccumulation.

In most instances, the monitoring strategy will have to have a combination of these approaches. The decision on what to monitor will depend on the local pollution problem, on the results of research knowledge gained, and pilot monitoring efforts being made before the design of a monitoring strategy. As a general guidance, these parameters will be selected to satisfy the monitoring needs of EPA and other local, State, and Federal groups.

The distribution of sampling stations and the frequency sampling must be selected in such a way that (1) the accepted design is cost effective, and (2) the sampling scheme can yield statistically valid results.

VII. SUMMARY AND RECOMMENDATIONS

The monitoring efforts currently being made or sponsored by the Federal Government have been analyzed according to four categories of activities:

(1) the surveillance of pollutant inputs,

(2) the monitoring of more ecosystems,

(3) the monitoring of food resources, and

(4) the monitoring of hazardous materials spills.

The analysis indicates that with the exception of the responsibility for the monitoring of marine ecosystems, Federal marine pollution programs are responsive to high-priority national needs. There does, however, appear to be a lack of concerted effort for assessing the health of ecosystems.

Principal criticism of the Federal effort focuses on the lack of centralized planning, coordination, accountability, and information retrieval. Other deficiencies involve less than adequate efforts to develop effective monitoring strategies, a standard bioassay methodology, a more cost-effective measurement and analysis technology, and to establish stringent quality assurance in the technology of measurement and analysis.

The major problem that this review of monitoring programs has identified is that a large number of discrete Federal, State, and local monitoring programs exist, each often planning, operating, measuring, and using data independent of and unaware of the other's existence.

To improve the monitoring effectiveness of the Nation's estuarine and coastal waters, all these monitoring efforts should be a part of a National Ocean Pollution Monitoring Program, and should respond to, or be part of, a regional monitoring strategy or plan. The following recommendations address this issue:

Establishment of a Federal Monitoring Program

- Establish federally funded and managed programs of ocean pollution monitoring for each highly stressed U.S. coastal region.

- Federal agencies and States should coordinate their monitoring programs for specific coastal regions and discrete bodies of water.

- Detailed monitoring plans should be developed regionally, because of the unequal coastal population density and industrial development, and because of the regionally different weather and oceanic climate.

The following regional divisions should be considered: Great Lakes, northeast Atlantic coast, southeast Atlantic coast, Gulf of Mexico coast, southwest Pacific coast, northwest Pacific coast, and Alaska coast. The regional plans and their implementation should be approved and coordinated by a management group (e.g., NOAA, EPA) under the advisement of an Interagency Steering Committee.

- Coordinated regional plans and new monitoring activities, as the first phase of the National Ocean Pollution Monitoring Program, should be implemented in FY 1981. Because of the critical pollutant stress conditions, public and institutional support, and the existence of a sufficiently complete research base, the initial new monitoring efforts should be in the northeast Atlantic coast and Great Lakes regions.

Establishment of a Federal Management and Coordination Structure

To remedy problems related to program emphasis, a strong technical management structure on a Federal level needs to be implemented. To support this, the following are recommended:

- Establish a management information system and a central data bank for all of the existing local, State, and Federal programs of marine pollution monitoring, and their data.

- Establish an Interagency Steering Committee to advise on the development of a National Ocean Pollution Monitoring Program.

- Establish regional centers to be responsible for the synthesis of monitoring information and data products into "management use" information.

- Establish guidelines for quality controls and standard methods for monitoring data acquisition and analysis technology. Federal data and analysis technology relevant to marine pollution should meet these guidelines. Federal support of relevant academic and industry research and monitoring should require adherence with the guidelines.

- Standardize monitoring data acquisition formats.

- Increase monitoring and research efforts by the Federal agencies to develop, test, and adopt standard marine bioassay methods.

- Increase Federal efforts to advance monitoring instrumentation technology (sensor development) and analysis methodology.

APPENDIX A.

Federal Agency Mandates and Responsibilities for Marine Pollution Monitoring and Research and Development Activities Related to Monitoring

Federal Agencies Having Mandates, Responsibilities, and Missions for Ocean Pollution Monitoring:

1. Environmental Protection Agency (EPA) A-2
2. Department of the Interior (DOI) 6
3. Department of Transportation (DOT) 15
4. Nuclear Regulatory Commission (NRC) 17
5. Department of Agriculture (USDA) 18
6. Department of Energy (DOE) 19
7. Department of Health, Education, and Welfare (HEW) 21
8. National Science Foundation (NSF) 23
9. National Aeronautics and Space Administration (NASA) 26
10. Department of Defense (DOD) 28
11. Department of Commerce (DOC) 33

ENVIRONMENTAL PROTECTION AGENCY (EPA)

The monitoring responsibilities--encompassing both the collection and use of data--are highly decentralized. At Headquarters, 16 offices, under five Assistant Administrators, are involved in various monitoring functions. Similarly, field responsibilities are dispersed among the 10 Regional Offices and 13 research laboratories.

The institutional relationships are further complicated by heavy involvement of other Federal agencies--principally the U.S. Geological Survey (USGS)--the States, and pollutant dischargers operating under effluent permits.

Ocean Monitoring data are used in a variety of ways, require an array of support systems, and involve a variety of program activities. Basically, data needs fall into four broad categories.

1. Provide Data for Developing, Assessing, and Revising National Strategies and Control Programs.

In the development of national control strategies, monitoring data are needed primarily to assess trends and develop environmental indicators. These measures are needed to provide focus to the strategy-setting process, especially with regard to selecting among alternative program strategies and resource allocations. The types of data required vary with the type of strategy under development: point source strategies need ambient data as well as effluent data, nonpoint source strategies need ambient data as well as intensive survey data, and toxic and hazardous pollutant strategies need all these data.

2. Provide Basic Data on the Effects of Pollutant Exposure in the Development of Revision of Models, Criteria, and Standards.

Monitoring data for developing models, criteria, and standards are of major importance to EPA, primarily because most of its water pollution control activities rest on these areas. Some of the most important uses in this category involve the following.

- Water Quality Models

  Data from intensive or special surveys are used extensively to develop and verify water quality models. This is particularly the case where complex hydrologic conditions exist such as in estuaries with poor mixing.

3. Water Quality Criteria/Ambient Water Quality Standards.

The Federal Water Pollution Control Act (FWPCA) requires States to adopt and enforce water quality standards for all navigable waters. Each standard consists of (a) criteria, representing the acceptable limits of pollutants in receiving waters to protect the designated use or uses of water; (b) the designated use of the water; and (c) an antidegradation statement. In development of revision of criteria, all types of monitoring data are used. Criteria for health-related uses such as domestic supplies, and protection and propagation of aquatic life rely to a great extent on measurements of dissolved oxygen and on biological and toxic monitoring data. Criteria for most other users tend to rely on the more traditional monitored parameters such as temperature, turbidity, pH, and dissolved solids.

4. Effluent Standards

FWPCA requires EPA to establish separate effluent standards for municipal and industrial discharges. The discharge of heat and toxic pollutants receives special consideration. Municipalities are required to provide secondary treatment by mid-1977 and "best practicable waste treatment technology" (BPWTT) by mid-1983. In developing a definition of BPWTT, monitoring data are needed, primarily on alternative waste management techniques.

o Dredge and Fill Permits

Monitoring of dredge and fill areas will be determined to a major extent by the types of areas involved and specific permit requirements.

o Ocean Dumping Permits

Monitoring of ocean dumping sites is needed primarily in the permit development process. In certain cases, however, continuing monitoring may be needed for compliance purposes.

5. Provide Monitoring and Case Support Data for Enforcement Activities.

Once standards have been developed and permit conditions set, there is a continuing need for monitoring data to support enforcement activities. Data needs fall primarily into the following areas:

o National Pollution Discharge Elimination System (NPDES) Permits

Compliance monitoring for NPDES is a major program area. This is handled primarily through review of self-monitoring reports. In many instances, however, followup monitoring is needed. This is handled by sampling and reconnaissance inspections. When actions are taken against dischargers, additional monitoring is generally required. The extent of such monitoring varies considerably and may involve ambient as well as effluent measurements.

o Pretreatment Standards

Industries that must meet pretreatment standards may be required to provide self-monitoring reports on their discharges. The EPA and/or the States will review these reports, if required, and conduct followup effluent monitoring inspections as necessary.

- Sewage Sludge Permits

  Compliance monitoring requirements have not been developed for sewage sludge permits. If sites are properly selected, there may be no need for monitoring.

  Two salient requirements are imposed upon industrial dischargers: existing industries use the "best practicable control technology currently available" by mid-1977 and "best available technology economically achievable" by mid-1983. Since effluent limitations must be developed for 46 major industrial categories and additional lesser categories, the need for data on specialized effluent monitoring is great.

  In addition, new sources of industrial pollution must use the "best available demonstrated control technology" (BADCT) which EPA is defining in the form of standards of performance for various industries. Again, effluent monitoring data are needed in defining BADCT for the various categories.

  The FWPCA also requires standards for industries whose effluents are treated by municipal treatment plants. In cases where the municipal treatment plants cannot effectively treat the effluents, pretreatment standards are required. Development of these standards also requires detailed data on effluent monitoring.

- Thermal Standards

  Discharge of heat is considered a pollutant under the FWPCA, so it is subject to water quality standards. Thermal standards are set for ambient waters as well as point source discharges. Development of such standards requires monitoring data, especially data that provide information on the responses of aquatic life to temperature changes and levels.

- Toxic Standards

  FWPCA provides for control of toxic pollutants through special effluent guidelines and ambient standards. Since dose-response relations for many toxic substances are not fully known, there is great need for specialized monitoring. Sophisticated sampling and analytical techniques are frequently required, because very low concentrations are dealt with in monitoring toxic pollutants. Because of difficulties with physical/chemical monitoring at low concentrations, increasing attention is being afforded biological monitoring.

6. Provide Data, Including Information on Baseline Conditions, for Developing and Revising Local Pollution Control Plans and Permits.

- NPDES Permits

  FWPCA requires that any discharge into the Nation's navigable waters from any point source may be made only in accordance with conditions of a discharge permit. Usually the permit conditions conform to nationwide standards such as best practicable technology, best available technology, and BPWTT. In the case of water-quality-limited segments of water bodies, however, limitations more stringent than nationwide standards may be required. To determine the levels of control needed, extensive use of effluent as well as ambient monitoring data is needed.

- Dredge or Fill Permits

  The U.S. Army Corps of Engineers is authorized by FWPCA to issue permits for disposal of dredged or fill materials in navigable waters. EPA frequently uses monitoring data to assess the impacts of such permits to prepare review comments by the Corps. Ambient and biological data are particularly important.

- Sewage Sludge Permits

  FWPCA requires EPA to develop regulations governing issuance of permits for disposal of sewage sludge. In developing regulations, monitoring data are required, primarily data on the migration of leachates to ground-water aquifers and surface waters.

- EPA Ocean Dumping Monitoring

  Section 102 of MPRSA authorizes the Administrator of EPA to designate recommended sites and times for the disposal of municipal and industrial wastes. Selection of the present sites was based on existing information on ocean dumping and historical usage, rather than on environmental criteria that emphasize minimal damage to the marine environment. Under the revised ocean dumping regulations, an Environmental Impact Statement (EIS) must be prepared for all permanently designated ocean dumping sites. EPA, in conjunction with NOAA and other organizations, prepared baseline survey guidelines for the collection of environmental data to support these EISs. This baseline survey program began in FY 74, and studies have been made on a continuing basis since that time. At present, a multimillion dollar, multiyear program to collect chemical and biological data on proposed and existing disposal sites is being implemented. These data will be used to evaluate impacts on the ocean, resulting from dumping under strictly regulated conditions, and to evaluate criteria. Specific locations along the East and West Coast and Gulf of Mexico will be monitored. Sampling frequency will vary with the site--from 5 days to 2 weeks per site. Although some monitoring has already been done, the program should be fully implemented in early 1979. At present, the data are not being stored in any computerized data system.

DEPARTMENT OF THE INTERIOR (DOI)

The ocean pollution research, development, and monitoring efforts within DOI are carried out by the Bureau of Land Management, U.S. Geological Survey, and the U.S. Fish and Wildlife Service.

Bureau of Land Management (BLM)

OCS Environmental Studies Program.

Introduction

In 1953, the Outer Continental Shelf (OCS) Lands Act of 1953 (67 Stat. 462) was passed establishing Federal jurisdiction over the submerged lands of the continental shelf seaward of State boundaries. The Act charges the Secretary of the Interior with responsibility for administering mineral exploration and development on the OCS, as well as conserving natural resources on the shelf. It empowers the Secretary to formulate regulations so that the provisions of the Act might be met and conflicts minimized. The authorities were strengthened and more specifically detailed by the OCS Lands Act Amendments of 1978 (Public Law 95-372). Additional authorities are derived from mandatory compliance with:

1. National Environmental Policy Act of 1969
2. Coastal Zone Management Act of 1972
3. Federal Water Pollution Control Act
4. Marine Pollution Research and Sanctuaries Act of 1972
5. Endangered Species Act of 1973
6. Marine Mammal Protection Act of 1972

The Submerged Lands Act of 1953 (67 Stat. 29) set the inner limit of authority of the Federal Government by giving the coastal States jurisdiction over the mineral rights in the seabed and subsoil of submerged lands adjacent to their coastline out to a distance of 3 nautical miles. There are two exceptions, Texas and the Gulf Coast of Florida, where jurisdiction extends to 3 leagues based on colonial charter.

Subsequent to passage of the OCS Lands Act, the Secretary of the Interior designated BLM as the administrative agency for leasing submerged Federal lands, and the Geological Survey for supervising development and production. The Department formulated three major goals for the comprehensive management program for marine minerals:

1. To ensure orderly development of the marine mineral resources to meet the energy demands of the Nation.

2. To provide for protection of the environment concomitant with mineral resource development.

3. To provide for receipt of a fair market value for the leased mineral resources.

These leasing objectives are based on legislative mandates as explained below.

1. Orderly resource development is based on the OCS Lands Act, as amended, which gives the Secretary the authority, in order to meet the urgent demand for oil and gas, to grant leases to the highest qualified bidder(s) on the basis of sealed competitive bids. Hard minerals, i.e., sand and gravel, are also subject to leasing in the same manner.

2. Protection of the marine and coastal environment is a direct outgrowth of the National Environmental Policy Act (NEPA) of 1969. This act requires that all Federal agencies shall use a systematic, interdisciplinary approach that will ensure the integrated use of the natural and social sciences in any planning and decision making which may affect the human environment. Additional emphasis was added to this requirement by the OCS Lands Act Amendments that require an environmental studies program to establish information needed for assessment and management of environmental impacts on marine and coastal environments that may be affected by development of OCS oil and gas.

BLM efforts in this direction are Environmental Impact Statements (EIS or ES), environmental assessment teams, environmental studies, literature surveys, socioeconomic studies, public conferences on problems affecting the human environment, and special studies that contribute to an understanding of the processes affecting this environment.

3. Receipt of fair market value has basis in two separate mandates. U.S. Code 31, Sec. 483 (a) obligates the Federal Government to obtain a fair return for public lands that are sold or leased. This is further implemented by Bureau of the Budget Circular A-25.

The Annual BLM Congressional Appropriations Bill gives BLM those monies necessary to carry out its required tasks. This is probably the strongest piece of legislation for any program, because it reflects the administration's desire to have a program administered by a certain agency, and it also shows Congressional approval. The Environmental Studies Program has received funds identified as specific line items in FY 75 through FY 79 budgets, and is also specifically identified in the BLM 4-Year Authorization document.

Objectives and Approach

The objectives of the Environmental Studies Program are "to establish information needed for prediction, assessment, and management of impacts on the human, marine, and coastal environments of the Outer Continental

Shelf and the nearshore area which may be affected . . ." The studies are designed to:

1. "Provide information on the status of the environment upon which the prediction of the impacts of the Outer Continental Shelf oil and gas development for leasing decision making may be based,

2. provide information on the ways and extent that Outer Continental Shelf development can potentially impact the human, marine, biological, and coastal areas,

3. ensure that information already available or being collected under the program is in a form that can be used in the decision making process associated with a specific leasing action or with the longer term Outer Continental Shelf minerals management responsibilities, and

4. provide a basis for future monitoring of Outer Continental Shelf operations."

Such information can be derived from existing sources or it can be new information generated from field studies. For results to be meaningful, the connection between the decisions and individual studies must be clear and logical. The ultimate purpose of the studies program is to ensure that the environmental information on which these decisions are based is complete, and is the most definitive that can be assembled at the time.

U.S. Geological Survey (USGS)

For nearly a century, the USGS has served Federal, State, and local governments, and the public, by collecting, analyzing, and publishing detailed information about the Nation's energy, mineral, land, and water resources. USGS was created in 1879 to study the geologic structure and mineral resources of the public domain and to provide information to support development of the West. Congressional and Executive direction later expanded the Survey's authorities and responsibilities to include topographic mapping; chemical and physical research, stream-gaging, and water supply assessments; supervision of mineral exploration and development activities on Federal and Indian lands; engineering supervision of waterpower permits; and administration of a mineral exploration program.

The ocean pollution-related research, development, and monitoring programs are carried out by Geologic Division, Water Resources Division, and Conservation Division.

Geologic Division

The Geologic Division conducts nationwide geologic research and investigation programs through continuing research and data collection, as a background for many economic and social decisions. Geologic research is used to determine the structure of the Earth and to develop a better understanding of processes that influence our lives, such as earthquakes, volcanic eruptions, and landslides. Geologic data on the Nation's land, mineral, and energy resources are continually being collected, analyzed, and published to inform the public and provide a rational basis for use with minimum damage to the environment of the Earth's surface and atmosphere. The geologic programs are distributed among four main fields of activity--Land Resource Surveys, Mineral Resource Surveys, Energy Resource Surveys, and Offshore Geologic Surveys.

Land Resource Surveys provide geological, geophysical, and geochemical data needed to evaluate the Nation's land resources, the effect of human activity on the land, and the hazards to human life and property posed by natural forces and processes.

Mineral Resource Surveys provide information on the Nation's resources of metallic and nonmetallic minerals, and studies of processes and mineral information provide a basis for identification of hitherto unknown sources of metallic and nonmetallic minerals. These studies concern public lands especially.

Energy Resource Surveys provide current, systematic, and thorough assessments of the Nation's energy resources. Information is established on the location, quantity, and quality of energy resources in the forms of coal, oil and gas, oil shale, uranium and thorium, and geothermal heat.

Offshore Geologic Surveys provide an assessment of the potential mineral and energy resources of U.S. continental margins. Studies are also made to determine the geologic and environmental hazards that may affect the siting of offshore drill rigs, production platforms, and pipelines.

Water Resources Division

In no area of resource management are the problems more complex, or more vital, than those involving the Nation's water. Managing water supplies is a major concern at all levels of government, but the Water Resources Division of USGS has the principal responsibility at the Federal level for appraising water resources and for providing basic hydrologic data on both surface and ground water.

The Survey's program, through its numerous cooperative arrangements with State and local governments, is uniquely structured to gather and evaluate water information scientifically. The Water Resources Division presents factual information and analyses for use by Federal agencies, State and local governments, and other groups charged with managing and developing water resources. The Division provides reports and maps to the public in Federal, State, and local publications and in technical journals. Also, material is made available for public use at selected libraries.

In the Water Resources Division's Federal-State Cooperative Program, 597 State and local agencies provide financial support and services, matching the funds appropriated by Congress. This arrangement assures that USGS is aware of and can be responsive to water information needs at all levels of government. It also keeps the Federal Government aware of State and local problems and contributes to a valuable exchange of information. Through a network of offices in all 50 States, as well as in Puerto Rico and Guam, the Water Resources Division works closely with State and local agencies.

A major responsibility for water data was assigned to the Survey in 1964 when it was designated the lead agency for coordinating water-data-acquisition activities of all Federal agencies, including information on streams, lakes, reservoirs, estuaries, and ground water. This coordination effort has minimized duplication of data-collection activities among Federal agencies and strengthens the overall data base and its accessibility.

Conservation Division

The Conservation Division performs several regulatory functions delegated to the USGS by the Secretary of the Interior under laws governing the leasing, mining, and use of mineral and water resources on Federal and Indian lands. These responsibilities are accomplished in two major missions:

- Classification of public lands in terms of their potential for leasable mineral resources and their value for water power and water-storage purposes, and evaluation of mineral tracts on public land that are subject to competitive leasing or to sale or exchange.

- Supervision of operations associated with the exploration, development, and production of minerals from leased Federal, Indian, and Outer Continental Shelf lands, including the collection of royalties and certain rentals that result from the minerals.

Data acquired by USGS while carrying out these functions also provide information to support the missions of other Federal agencies who share responsibilities for the sound development of resources and protection of the environmental characteristics found on public lands. These agencies include the Bureau of Land Management, the Bureau of Indian Affairs, the National Park Service, and the Bureau of Reclamation within the Department of the Interior, as well as the Department of Defense, the Forest Service, the General Services Administration, and the Environmental Protection Agency.

A recently published Survey document describes an organized and systematic program to assure safe, environmentally sound exploration, development, and production of oil and gas found on the Outer Continental Shelf.

This OCS program incorporates many recommendations from recent independent studies of offshore oil and gas production activities by the National

Aeronautics and Space Administration, the National Academy of Engineering, the University of Oklahoma, and the Council on Environmental Quality. Recognizing that the responsibilities of the Geological Survey on the OCS are extensive, specific elements of this program have been designed to assure that all OCS operations are conducted in a way that best emphasizes safety of operations and prevention of environmental damage.

The functional elements of this lease-regulatory program are based on the concept that fundamental responsibility for safe OCS operations lies with each lessee and that it is the role of USGS to provide oversight of the entire sequence of activities associated with oil and gas production. In a major review of the program, several existing USGS procedures have been revised and new procedures introduced to reflect an increasing emphasis on the responsibilities of each lessee. These new and revised functional elements extend beyond actual lease activities in some instances. New requirements, for example, stipulate that safety equipment comply with standards developed by the Geological Survey and that drilling and production platforms be designed and installed in accordance with new USGS criteria. Even inspection procedures covering actual offshore facilities have been modified through addition of a provision that requires each lessee to perform a prescribed inspection routine at periodic intervals and take specified corrective action for any deficiency. Other major components of the program require lessees to report equipment failures, make a design analysis of offshore platform production systems, and perform other related actions with the intention of identifying and eliminating problem areas--and so prevent accidents.

The regulation of OCS oil and gas activities is a continuing process requiring constant review of program components and objectives. As oil and gas production becomes more complex and is undertaken in sometimes hostile new environments--off the Alaska and Atlantic coasts, for example--this "new direction" in regulatory activity seeks to ensure that offshore oil and gas operations will be carried out in a way that emphasizes safety of operations, with a minimum risk of environmental damage.

U.S. Fish and Wildlife Service (FWS)

Under the National Environmental Policy Act, the Fish and Wildlife Coordination Act, and other Federal legislation, FWS has been involved in many environmental issues, both through research and on an operational basis. The Biological Services Program is one of three interrelated FWS programs dealing with environmental issues. The other two are the Land and Water Resource Development Program and Environmental Contaminant Evaluation Program.

The Land and Water Resource Development Program, managed through the Division of Ecological Services, provides consultation, field evaluation, and planning assistance for proposed water and related land projects to be constructed by Federal agencies, assisted with Federal funds, or constructed by non-Federal entities under a Federal license or permit. The Program provides ecological input to field level planning related to specific river basin studies and assures Fish and Wildlife Service compliance with the National Environmental Policy Act.

The Environmental Contaminant Evaluation Program involves research studies, contaminant monitoring, and field appraisals to ascertain the effects of pesticides, industrial chemicals, heavy metals, and pollutants on fish and wildlife and their habitats. This program prepares and reviews all Service uses of pesticides. Much has been accomplished toward uncovering the relationship between the application of pesticides and damage to fish and wildlife.

The increasing number and complexity of major projects for land and water development has required that the Service upgrade its response capability by improving the basic data, methodologies, and predictive tools available. It has been obvious that much of the damage to fish and wildlife resources, stemming from new land and water developments, could have been avoided or mitigated if projects had been planned with greater consideration for environmental values and if conservation recommendations had been better justified in terms of cost. At the same time, it has become apparent that the Service must have a capability of assessing project impacts more rapidly and accurately if it is to stay abreast of the deluge of new projects related to energy, impairment of wetlands, and proposed changes in land and water use. In short, the operational part of the Service needs to be strengthened and provided with the means for becoming more effective and more efficient.

To remedy this situation and reinforce the Fish and Wildlife Service's role as a central source of ecological expertise and information in the Department of the Interior, the Service has created the Biological Services Program. The Program has been given a high priority to accomplish the following threefold mission:

1. To strengthen the FWS in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.

2. To gather, analyze, and present information that will aid decision makers in the identification and resolution of problems associated with major changes in land and water use.

3. To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy.

In performing its mission, the Biological Services Program acts as a bridge between FWS activities at the research level and those at the field operations and management levels. In addition to supporting research and studies on critical environmental problems, Biological Services is synthesizing scientific research data into operationally useful guidelines and manuals and providing technical assistance on environmental problems directly to FWS Regional Offices, as well as other agencies. Over a period of time, this work is expected to enhance greatly the Service's ability to provide pertinent information on wildlife resources and their supporting ecosystems throughout the country.

The Program helps the FWS participate in the decision-making process for major resource development projects in a manner that helps narrow the traditional conflict between economic development and environmental protection. For example, under an order issued by the Secretary of the Interior, FWS is providing expert advice to the Bureau of Land Management and the Geological Survey on ecological problems associated with development of new resources of oil and gas on the Outer Continental Shelf. The Service is also developing information that will assist in finding the least damaging ways of bringing the oil and gas ashore and in determining the best locations for shore-based facilities. Within the various oil and gas lease areas, FWS is identifying critical zones that should not be developed and is analyzing alternatives to preserve these critical areas while projects are in the early planning stage, when options are still available. Strengthened coordinated activity among the Department's agencies is expected to be extended to other areas of energy, land, and water development.

The coastal ecosystem and Outer Continental Shelf development project reflects the growing importance of accelerated development of offshore oil and gas and its effect on the Nation's coastal systems, as well as effects of more traditional forms of coastal alteration. The project is developing approaches to characterize the coastal areas to better understand, predict, and compensate for multiple impacts of development on fish and wildlife resources. Particular emphasis is being placed on potential impacts on coastal birds, endangered species, and high-value habitats. In addition, this project supports Service participation in the Department's Outer Continental Shelf (OCS) Development Program. A manual is being developed for evaluating how the full range of offshore oil and gas development will affect coastal ecosystems.

A five-step process is used to provide a national perspective and coordinating mechanism for management of information and technology. The five steps are:

- Identification of User Needs
- Communication of Needs
- Development of Information and Technology
- Dissemination of Information and Technology
- Evaluation of Information and Technology

The major innovations presented in the procedures are the systematic linking of user needs with the program planning and budget process and the evaluation of the effectiveness of the information and technology disseminated.

DEPARTMENT OF TRANSPORTATION

U.S. Coast Guard (USCG)

USCG, under the Secretary of Transportation, has primary responsibility for assuring the safe movement of vessels in the marine transportation mode and preventing or mitigating damage to the marine environment resulting from the transport of oil and hazardous chemicals within and on the ports and waterways of the United States. This responsibility is defined within the Ports and Waterways Safety Act, Port and Tanker Safety Act, Tank Vessel Act, Federal Water Pollution Control Act, and Dangerous Cargo Act to name a few. To accomplish this, USCG regulates and enforces comprehensive minimum standards of design, construction, alteration, repair, maintenance, and operation of vessels; takes a variety of actions, including but not limited to actions to control or supervise vessel traffic and operations along the waterfront; regulates and enforces the handling, storage, and carriage on board any vessel such materials as: explosives, flammable liquids or solids, oxidizing materials, corrosive liquids, compressed gases, poisonous articles, and all hazardous materials in bulk transport. The Coast Guard also has significant responsibilities for the prevention and mitigation of pollution emanating from activities under the Outer Continental Shelf Lands Act and the Deepwater Port Act, or which may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the United States (including resources under the Fishery Conservation and Management Act), as specified in the above mentioned Acts and the Federal Water Pollution Control Act.

Under the Federal Water Pollution Control Act, Oil Pollution Act Amendments of 1973, and the Marine Protection, Research, and Sanctuaries Act, USCG undertakes the surveillance and other enforcement activity to prevent and detect unlawful discharges of oil, hazardous substances, unlawful material for dumping, or unlawful dumping. Since the problem of marine pollution is universal, it is imperative that an active international program exist to prevent willful and accidental pollution of the marine environment. Fortunately, such a program is conducted under the auspices of the Intergovernmental Maritime Consultative Organization (IMCO), an element of the United Nations. Because of its role in marine transportation management within the United States, the Coast Guard normally serves as the coordinating U.S. representative at IMCO. This organization has been extremely active over the past few years, principally in response to a call by President Carter for international action following a series of tanker accidents in or near U.S. waters. The President's Initiatives are considered to have resulted in many important new measures and procedures to improve safety and prevent the pollution of the sea (including discharges resulting from operational practices).

Once an oil or hazardous substance spill occurs in the coastal regions, ports, harbors, and Great Lakes of the United States or there is a potential for such an incident occurring, USCG is authorized (Federal Water Pollution Control Act, Outer Continental Shelf Lands Act, Deepwater

Ports Act, Intervention on the High Seas Act) to take actions to mitigate the threat or remove the pollutant unless the responsible party is taking appropriate actions. In this regard USCG operates a National Response Center to receive notification of discharges and to disseminate reports to the Federal official responsible for responding to the discharge. USCG has also established highly trained Strike Teams to respond to major pollution discharges.

USCG carries out, under various authorities, an active research and development program to support the commercial vessel safety, marine environmental protection, and port safety missions. In accomplishing this, the USCG cooperates with the Maritime Administration, Environmental Protection Agency, other interested Federal agencies, other maritime countries and the maritime industry, and maintains a Research and Development Center and a shipboard Fire and Safety Testing Facility.

USCG mandates for monitoring are more to assist other agencies with resources and personnel than in specifically monitoring ocean pollution. One example is the assistance given NOAA and EPA in ocean dumping research where monitoring is involved. In addition to specific legislative authority to conduct monitoring for particular programs (e.g., Title II, Marine Protection, Research, and Sanctuaries Act), the Coast Guard has ample authority to engage in oceanographic research, including monitoring, as indicated here:

a. USCG has authority to conduct or engage in oceanographic research on its own responsibility in any area necessary or desirable for the furtherance of its other authorized missions.

b. USCG, in the national interest, has specific authority to conduct or engage in oceanographic research on its own responsibility in any area that has not been specifically granted to any other Government agency. This is a separate and primary mission in and of itself. In carrying out any such project, the Coast Guard may, if it wishes, seek and obtain the cooperation and assistance of any other government agencies.

c. USCG has authority to conduct or engage in oceanographic research in cooperation with other government agencies that are vested with specific statutory authority in the areas concerned. In these situations USCG is not authorized to conduct or engage in oceanographic research independently.

d. USCG has the authority and, in some cases, is required to conduct or engage in oceanographic research in support of its various environmental protection programs and those of other agencies.

NUCLEAR REGULATORY COMMISSION (NRC)

NRC is specifically directed by the Energy Reorganization Act of 1974 to perform only confirmatory research; thus the environmental research programs are relatively modest and restricted to specific problems encountered during the nuclear regulatory process.

In like manner, NRC performs little monitoring. It does, however, stimulate monitoring programs by licensees and applicants for licenses via licensing requirements. These monitoring programs are divisible into (a) baseline studies performed by potential applicants prior to their submitting an application, (b) pre-operational studies that focus on potential problems identified during the baseline study, and (c) post-operational monitoring programs to assure compliance with license conditions. The licensee involved performs these monitoring programs, which are under his management. The results of the studies are made available to NRC. The scope of these monitoring programs is closely related to the needs of the licensee and hence may be quite limited in area, duration, and parameters monitored.

The baseline studies are primarily to provide information needed by NRC to prepare the Safety Analysis Report and the Environmental Impact Statement required by law. The guidance for these studies is contained in Regulatory Guide 4.2, Revision 2, "Preparation of Environmental Reports for Nuclear Power Stations," and in the chapter on Site Characteristics of Regulatory Guide 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."

The bulk of the operational monitoring programs conducted by licensees focuses on potential radionuclide pathways to man. The staff has prepared several documents to help licensees carry on these monitoring programs.

In addition to the foregoing, the NRC Office of Inspection and Enforcement (IE) has contracts with 16 States to perform spot check monitoring for quality assurance. These programs are limited in scope and vary as to location and content. IE also maintains an in-house capability to perform radiological monitoring in response to specific incidents and in connection with the NRC emergency preparedness program.

DEPARTMENT OF AGRICULTURE (USDA)

The mission of USDA research is to develop new knowledge and technology that will maximize production of high quality agricultural commodities and products at reasonable prices while minimizing the detrimental effects of agriculture on the quality of the environment. In relation to the oceans, estuaries, and Great Lakes, this mission focuses on the development of technical information and technical products needed to manage and use the Nation's soil, water, and air, and climate resources in a manner that will minimize pollution of receiving water (e.g., oceans, lakes) and improve the quality of the Nation's environment. The research performed by USDA is authorized by the Department of Agriculture Organic Act of 1862; The Research and Marketing Act of 1946, as amended; the National Agricultural Research, Extension, and Teaching Policy Act of 1977; and other congressional mandates.

USDA carries out its research program through inhouse research, by cooperative research with Land Grant, State, and other universities and institutions, and by contract and grants.

The USDA programs of research, development, and monitoring related to the pollution of oceans, estuaries, and the Great Lakes deal with problems of agricultural runoff and waste disposal. To understand the interaction of agriculture and ocean pollution, USDA studies the transport, transformation, and environmental effects of sediment, nutrients, and pesticides in different organisms and in different ecosystems. The purpose of this research is to understand the possible offsite/downstream effect of agriculture on natural ecosystems so that agricultural production systems can be designed to minimize the detrimental effects of agricultural pollution while maximizing agricultural production.

DEPARTMENT OF ENERGY (DOE)

Partially because of the amalgamation of different government entities that took place when DOE was established, and partially because of the diverse activities encompassed by a subject such as marine pollution, programs in this subject area exist within a number of offices in DOE. The Strategic Petroleum Reserve, for example, is administered under the Assistant Secretary for Resource Applications. This office does environmental work related to NEPA requirements and particularly to the disposal of concentrated brines in the Gulf Coast regions of Texas and Louisiana.

The DOE Division of Solar Energy is working on marine-related energy conversion technology, particularly ocean thermal energy conversion (OTEC), to harness thermal gradients between surface and deep ocean water. As part of the OTEC program, heat exchangers are being developed at laboratory and bench scales preliminary to ocean testing. In bioconversion, experiments in kelp culture are underway; in wind energy conversion, studies of offshore windmills are beginning; and technological assessment of other ocean energy options is in process, especially as related to waves, tides, current-driven turbines, and salinity gradients.

The major marine research activity of DOE is carried out by the Office of Health and Environmental Research under the Assistant Secretary for Environment. Responsibility for a "comprehensive program of research and development on the environmental effects of energy technologies and programs" is legally mandated. The existing program was built on the foundations of a program that came into being under the Atomic Energy Commission.

The objectives of the DOE program are:

1. To predict transport and diffusion of energy-related releases in the coastal zone.

2. To understand pathways and fates of energy-related compounds from different sources into physical and biological systems.

3. To determine dynamic functioning of ecosystems and their resilience to disturbance by energy activities.

Two major kinds of research activity are performed. In part, the program is directed at the specific needs of a specific technology, such as OTEC, and, in part, it is directed at generic questions, such as the emission of chlorinated organics from powerplant cooling systems. Historically most of the program was carried out by university contractors, because the National Laboratory System did not have the capability for oceanographic research. While most work is still done offsite, there is now more within DOE facilities.

Geographically there are programs in place in the Northwest Atlantic (conducted by Brookhaven National Laboratory), in the South Atlantic Bight (SAB), on the California coast, and in the Pacific Northwest. The SAB program is administered by Skidaway Institute of Oceanography. Scripps Institute of Oceanography coordinates the California program, and the University of Washington, the program in the Northwest.

The content of these programs is varied and includes the following:

Distribution and dispersion of trace metals through rivers and estuaries onto the Continental Shelf, and the effects of air pollutants on coastal ecosystems (Skidaway Institute of Oceanography, University of Georgia, and Yale University).

Processes that control the production of microscopic plant life in order to assess potential effects of energy developments (Brookhaven National Laboratory and Chesapeake Bay Institute).

Influence of the Gulf Stream and winds on current patterns to determine the transfer mechanisms for pollutants and nutrients along the Continental Shelf (Skidaway Institute, University of Miami, and North Carolina State University).

Movement of plutonium and tritium in coastal waters and resulting concentrations in marine life, and development of a computer model to help predict future effects of energy development (Savannah River Laboratory, University of Georgia).

Microbial, invertebrate, and fish populations, and the movement of trace elements and radionuclides in the estuaries and coastal waters near Beaufort, N.C. (National Marine Fisheries Service, National Oceanic and Atmospheric Administration).

Basic biological processes that affect the survival of plant and animal communities on the Continental Shelf, including examination of microorganisms, to assess possible polluting effects of oil spills and heated water releases on these processes (Scripps Institution of Oceanography, University of Washington, and Pacific Northwest Laboratory).

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE (HEW)

Public Health Service

Food and Drug Administration (FDA)

A major mission of the FDA is to prevent the introduction in interstate commerce of foods that are adulterated or contaminated. As part of its overall responsibility to eliminate contaminated food products, FDA inspects samples of fresh and processed sea foods. In addition, FDA administers the National Shellfish Sanitation Program (NSSP), a State-Federal-Industry program for the sanitary control of the molluscan shellfish industry. The major orientation of NSSP has been monitoring of shellfish habitat conditions to determine safety for human consumption. NSSP also provides a quantitative measure of pollution-induced impacts on estuarine habitats. The National Shellfish Register of Classified Estuarine Waters summarizes data on the commercially available shellfish-producing waters as affected by closures and openings of areas based on bacteriological and other conditions. The Register has been published in 1966, 1971, and 1974. This series gives an extremely useful indication of trends in degradation and improvement of estuarine and ocean shellfish habitats as affected by both pollution and pollution abatement, particularly with respect to domestic sewage. If prepared annually and if State-supplied information were standardized and expanded, the Register would become an even more effective monitoring tool for shellfish resource management and pollution abatement evaluation. FDA does not have regulatory, licensing, or enforcement authority in this program. The NSSP includes oysters, clams, and mussels. General operations of the program within the States are managed by State Control Agencies, with FDA providing coordination at the Federal level. State shellfish control agencies monitor, classify, and control about 14 million acres of actual and potential shellfish growing waters, out to 3 miles from shore. FDA does not generally monitor State territorial waters, but provides technical assistance upon request to study specific pollution problems. These studies are directed at defining proper closure lines for growing areas affected by pollution. FDA evaluates State programs, provides technical assistance and training, and conducts research for the development of program standards and criteria. Research on contaminants includes viral and bacteriological microorganisms, toxic metals, radionuclides, and naturally occurring marine toxins. Under the NSSP, the FDA also monitors offshore dumping sites to determine the effects of sludge dumping on the sanitary quality of the sea clam growing area waters and sediments and to provide necessary data to establish closure lines for sea clam harvesting. Ocean monitoring surveys are usually operated in conjunction with EPA, NOAA, and USCG projects.

National Institutes of Health (NIH)

The general mandate of NIH is to provide leadership and direction to programs designed to improve the health of the people of the United States. The NIH function statement contains a specific mandate to conduct and support research on the biological effects of environmental contaminants. These research activities produce data for the design of monitoring systems -- pointing out important parameters and setting concentration limits.

NIH also has a commitment to develop a research support program on the effects of environmental contaminants in the ocean. The national Institute of Environmental Health Sciences has established a Marine/Freshwater Biomedical Center Core Grants Program. The objective of the Core Grant Program is to encourage marine/freshwater science centers to use part of their resources for research in environmental health sciences. Under this program, grants have been awarded to Oregon State University at Corvallis, University of Southern California at Los Angeles, and Duke University Marine Laboratory at Beaufort, N.C.

NATIONAL SCIENCE FOUNDATION (NSF)

NSF supports scientific research that leads to greater understanding of the complex marine ecosystem. It is only through a full understanding of the natural system and its behavior under stress that wise choices can be made concerning the ultimate costs of multiple usage of and multiple impact upon such a complex ecological system. NSF does not conduct this research itself, rather it funds research by members of the scientific community under authority of the National Science Foundation Act of 1950 as amended. Awards are made in response to solicited and unsolicited proposals submitted directly to the Foundation. Award of funds depends on the merit of the proposed research as judged by peers in the scientific community and the Foundation staff. Excellence and relevance of the scientific results is assured by standards of merit that include relevance to the specific field of study, originality of approach, and likelihood of success.

Research of immediate application to ocean pollution problems and needs is funded through the Division of Ocean Science. Because NSF is primarily a sponsor of basic research, it is also highly likely that advancements leading to better ocean management will come from research funded through its nonmarine divisions. Most of the sponsored research is conducted in academic institutions, although joint industrial-academic projects are possible under certain conditions.

The Ocean Science Division is divided along traditional lines with each program having a primary interest in physical, biological, chemical, or geological oceanography.

Broader projects especially susceptible to concerted efforts by interdisciplinary research teams is supported by the International Decade of Ocean Exploration. This program is unique in that it brings major efforts to bear on globally planned and coordinated studies of the ocean as a system. Funded research is directed toward several goals, among which are:

a. To preserve the ocean environment by acceleration of scientific observation of the natural state.

b. To develop and improve predictive models of ocean conditions to permit more effective use of marine resources.

c. To expand seabed resource assessment to permit better management of ocean mineral exploration.

d. To recognize natural resources.

Our interpretation of both the NSF Act of 1950 and the Vice Presidential charge of 1969 for an International Decade of Ocean Exploration is that primary emphasis at NSF is on basic research. For this reason, Foundation support has been directed toward the elucidation of processes and mechanisms rather than toward applications of current technology for monitoring and regulation. Since a realistic interpretation of time series observations for the purpose of monitoring chemical pollution requires an understanding of the processes causing concentration changes in a chemical species, basic research and monitoring should be coupled. Such coupling also takes place whenever monitoring is required for a goal to be reached in basic research.

A specific example of NSF funded research in marine science that bears on monitoring activities is the characterization of chemical influences on eutrophic blooms in coastal waters. It has been speculated that, along with unique meteorological conditions, organic matter and metal co-factors for bacterial and plant growth triggered the red tide bloom observed in the summer of 1976 off New Jersey. It is not possible to determine the cause of this or similar events in the future without an understanding of the processes controlling the supply and oxidation of organics as well as ventilation of the water mass. With long-term monitoring of a pollutant like lead, for example, variations may arise simply from natural variations in productivity and ocean mixing.

Some projects funded through the International Decade of Ocean Exploration Section have required revisiting areas of the ocean where extensive studies were made of chemical constituents. Although the scope of such studies falls short of a monitoring program as we are defining it, some of the data obtained from stations reoccupied might be of value to a monitoring data base. One example of these studies is a GEOSECS (Geochemical Ocean Section Study) station that will be revisited next year for intensive study of metals, nutrients, and radiochemicals in the water column. In addition, projects involved in the recyling of carbon species in the oceans are being planned and, if funded, will provide water analyses from many of the stations previously occupied by GEOSECS.

Intermediate between open ocean monitoring and laboratory experiments with both flow and batch systems is a study funded by the Foundation in 2000-cubic meter plastic bags in Saanich Inlet, British Columbia. Chemical and biological species are monitored within the moored containers during 1- to 3-month experiments. Community response to natural changes in light, mixing, and predation will be assessed as a control with which the effects of added nutrients and food can be compared.

A third area of research that may produce data useful to the objectives of a monitoring program is the study of atmospheric fallout at Eniwetok, in a remote region of the Pacific. Here trade-wind transport of particles will be investigated during two 1-month studies during 1979.

Although none of these three examples of current research activities in pollution-related research fits the monitoring aims, their inclusion in this survey may help sharpen our definition of monitoring activities.

Physical Oceanography

The primary objective of sponsored research is to better understand and model the ocean circulation. Knowledge about transport processes over many scales is needed to predict the movement of pollutants from a variety of sources.

Marine Chemistry

An important portion of the research supported is directed at better understanding of air-sea and sea-sediment exchange phenomena which will determine the seas' capacity to be a sink or source for manmade chemicals and other pollutants.

Submarine Geology and Geophysics

Studies of marine sediments and the processes of sedimentation are supported. Such studies will lead to a better understanding of the fate of seafloor-disposed wastes.

Biological Oceanography

This program supports research that is directed at a better understanding of the function and structure of marine biological systems in relation to the physical, chemical, and geological environments of the ocean. Systems that range from the cellular to the whole ocean are being studied with the awareness that the behavior of these systems in natural and polluted environments must be known to avoid management decisions that lead to irreparable damage.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA was established by Public Law 85-568, the National Aeronautics and Space Act of 1958. This act declares that "it is the policy of the U.S. that activities in space should be devoted to peaceful purposes for the benefit of all mankind." The activities are to contribute to the following objectives: (1) "The establishment of long range studies of the potential benefits to be gained from . . . the utilization of aeronautical and space activities for peaceful and scientific purposes," (2) "The preservation of the role of the U.S. as a leader in aeronautical and space science technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere," and (3) "The most effective utilization of the scientific and engineering resources of the U.S. with close cooperation among all interested agencies of the U.S. . . ." In the performance of its function, the NASA is authorized ". . . to enter into . . . cooperative agreements . . . with any state . . . or with any political subdivision . . . to cooperate with other public and private agencies." It is recognized that NASA does not have a direct statutory responsibility for any monitoring activity. In some instances, however, Congress has directed other agencies to seek assistance from NASA. In the Federal Water Pollution Control Act of 1972, Public Law 92-500, the Administrator of EPA is charged with establishing "national programs for the prevention, reduction, and elimination of pollution and as part of the program shall . . . establish, equip, and maintain a water quality surveillance system . . . and . . . conduct such surveillance by utilizing the resources of the NASA, NOAA, USGS, and the USCG . . . ." In other instances, Congress has also directed the emphasis of NASA and projects through specific actions. For example, in the NASA Authorization Appropriations actions for FY 1978, the Congress identified support for "the investigation of potential of satellite systems to detect and monitor oil spills in U.S. waters," and "in addition to oil spills, NASA should also investigate the application of space technology to the monitoring and control of other ocean pollution problems such as waste disposal."

Although NASA has no legislated responsibility for the regulation, control, or the operational monitoring of water pollutants, NASA does respond to the question: How can the NASA remote-sensing capability and its advanced technology contribute to the solution of these water quality problems of national concern? Through addressing this question, NASA has entered into several interagency agreements and memoranda of understanding. Some of these include: EPA-IAG-PG-0930: Evaluation of an Electrochemical Method for Detecting and Monitoring Coliforms in Coastal Waters; EPA-IAG-0245: Evaluation of Remote Sensors for Detection and Monitoring of Water Quality; EPA-IAG-D6-0483: Study of Great Lakes Pollution From Land Use Activities.

NASA's ocean pollution activities are divided into four projects, which are summarized below:

1. Analysis and Interpretation of Remotely Sensed Great Lakes Water Quality Data:

The objective is to investigate additional methods for the analysis and interpretation of remotely sensed data for water quality and pollution parameters as derived from cooperative programs with EPA and other users in the Great Lakes.

2. Coastal Zone Investigations for Ocean Dumping and Environmental Baseline Monitoring:

The objective is to perform an evaluation of the application of existing remote-sensing techniques to ocean dumping monitoring tasks and to perform those analytical, laboratory, and field investigations required to evaluate the role of remote sensing to the monitoring of water quality problems in the coastal zone, including those activities associated with offshore development.

3. Develop and Investigate Potential of Space Technology for Oil Spills and Ocean Pollution Monitoring:

The overall objectives are to evaluate the potential and to develop remote-sensing technology for the monitoring of oil spills and ocean pollution. A particular emphasis is to be an assessment of the potential of satellite systems using current space technology to detect and monitor oil spills in U.S. waters.

4. Red Tide and Characteristics of Coastal Zone Water Quality:

The primary objective is to develop and demonstrate techniques to detect and discriminate between red tide and other related plankton blooms and to infer bloom concentrations from remotely sensed data.

While the above activities are the only NASA projects that have previously been identified as directly involved with ocean pollution research, development, and monitoring, there are many other ocean-oriented activities that can provide ancillary information relevant to pollution. Much of the microwave sensor work is directed toward the development of methods and systems for remotely observing and modeling ocean phenomena including air/sea interaction, surface conditions, general ocean circulation, and the associated transports of mass, heat, and nutrients. Studies are underway in the area of ocean color where the goals center around satellite measurements of features such as ocean fronts and their relevance to productivity and fishery management. The importance of these types of program goals in aiding our understanding of pollutant transport, fate, and effect is obvious.

DEPARTMENT OF DEFENSE (DOD)

Department of the Navy

The Department of the Navy has a highly focused program aimed at those problems unique to the Navy mission. Most of the environmental quality research within the Navy is in response to standards established by other regulatory agencies.

Most of the problems associated with permanent installations, i.e., sewage disposal, solid waste, etc., can be handled with conventional technology developed by non-DoD activities. Some problem areas are, however, unique to Defense and require Defense efforts to solve them. While actual warfare cannot be conducted with environmental conditions being considered foremost, conditions during training and peacetime operations will be made to conform with required standards.

- Shipboard storage of wastes will require inordinate amounts of space and major redesign unless better integrated on-board disposal systems are developed.
- Munitions production poses some particularly difficult waste disposal problems that are unique to the military mission.

Because the primary operational media for the U.S. Navy are the oceans of the world, it is only natural that the oceanic environment should be the object of extensive research within DOD. The Navy's research program in oceanography is not directly supporting the objectives of Public Law 95-273, but rather indirectly provides a basic infrastructure that can support a better understanding of the fate of many oceanic pollutants.

Transportation

The ocean is the major operations area for Navy transportation. It is essentially a hostile environment to man and machine. To operate effectively in such an environment, steps must be taken to overcome the deleterious effects of marine organisms responsible for fouling ocean-going or ocean-implanted equipment. Many approaches to antifouling technology, however, contribute to the pollution problem, affecting more than the specific target organisms. The Navy has a moderate program aimed at studying the pollution effects of antifouling technology and associated areas of concern.

Research programs with this general goal include:

- Marine Biology.

  A study of Navy operations on marine biology.

- Assessment of Marine Environmental Quality.

  A program to develop, for Navy use, technology for assessing and quantifying marine environmental quality wherever the Navy operates.

Waste Disposal

This is the major thrust of the Navy's ocean pollution program.

Exploratory development efforts include shipboard evaluations of short-lived detergents as bilge and deck cleaners and procedures to improve shipboard systems for sewage treatment.

Advanced development programs include the development of an integrated system for the disposal of all shipboard wastes (trash, sewage, garbage, bilge water, etc.) to avoid pollution; the development of practical oil/water separation systems for shipboard use with associated oil monitoring instrumentation; and the development of ports and land-based systems for industrial wastewater treatment. The specific Navy development programs are listed below:

- Integrated Waste Systems

  Design of a volume-, weight-, and manpower-constrained integrated waste system for shipboard use.

- Treatment of Sewage

  A project to improve shipboard sewage treatment facilities.

- Treatment of Oily Waste

  Technologies for engineering into oil/water separator systems for shipboard use.

- Treatment of Dry Dock Wastewater

  Development of treatment technology for processing drydock wastewater discharges.

- Reduction of Sedimentation at Berths and Docks

  Development of procedures and equipment which reduces pollution by dredge spoils.

- Integrated Water/Wastewater Systems

  Development of techniques for wastewater reclamation.

- Shore-Based Separation of Ballast Oil and Water

  Development of pierside equipment to treat contaminated ballast wastewaters from tankers and ships.

The Navy has a unique pollution problem that does not fall directly into any of the above categories, but rather may affect all. Ordnance manufacture and use create unique pollution substances. The Navy has several programs aimed at this problem.

- Water Monitoring Techniques for Ordnance Compounds

  Development of instrumentation for effective monitoring of very low concentrations of explosive and propellant constituents in process waters.

- Water Purification

  Development of techniques and equipment for the removal of explosive components from plant process water.

- Underwater Explosion Tests

  Development of guidelines that minimize harmful environmental effects from underwater explosions.

- Toxic Substances

  Development of processes for toxic waste reduction and treatment.

- Health Criteria

  Development of biomedical data for Navy unique materials and chemicals.

Army Corps of Engineers

The U.S. Army Corps of Engineers has a major national role in civil works program. Not directly associated with military requirements, the Corps programs center around their responsibilities in waterways management. Activities in the various ocean use areas are described below.

1. The Corps of Engineers has activity associated with transportation. These activities are carried out in association with their waterways management charter.

   - Educator Systems for Sandtrap Bypassing

     Development of effective systems for bypassing sand at tidal inlets.

- Cause of Navigation Channel Shoaling

  Studies of sedimentation problems in navigation channels.

2. Waste disposal is the major thrust of the Corps of Engineers program. The individual elements of the current program are described below.

   - Long-Term Aquatic Disposal Studies

     Open water disposal studies to include (a) population dynamics of benthic invertebrates, (b) PCB mobility, (c) resource value of disposal site, and (d) associated sediment dynamics

   - Monitoring of Field Study Sites for Selected Habitat Development

     Studies in the use of dredged material for habitat development.

   - Quality of Marsh Water

     Evaluation of various techniques for modeling marsh/estuarine water quality and ecology.

   - New Dredging Concepts

     Development of procedures and techniques for applying newly developed dredging equipment.

   - Erosion Control of Scour During Construction

     Improved methods of predicting and controlling scour.

   - Effect of Depth on Dredging Frequency

     Determination of most efficient dredging strategy

   - Predictive Modeling of Sedimentation

     Evaluation of the adequacy of physical hydraulic model predictions.

3. Coastal development and recreation is another area of major emphasis in the Corps of Engineers program. Although not specifically pollution related, these programs are aimed at proper understanding of the forces affecting coastal development.

   - Effect of Broken Armor Units on Breakwater Stability

     Determine the percentage of broken armor units permitted before the effectiveness of the breakwater is reduced.

- Stability of Breakwaters

  Model studies of breakwater structures.

- Studies of Catastrophic Flooding

  Evaluation of the numerical simulation of storm surges and tsunami predictions.

- Offshore Dredging Systems

  Study of beach nourishment techniques.

DEPARTMENT OF COMMERCE (DOC)

National Oceanic and Atmospheric Administration (NOAA)

NOAA has long standing responsibilities for providing information on oceanography, weather, and maps and charts that are needed for ocean operations, research, and development on the physical and biological characteristics of the ocean; and technical support for the fishing community. Since NOAA's creation, the Congress has enacted a substantial number of pieces of legislation giving NOAA a wide range of responsibilities in fields closely allied to ocean pollution. These legislative mandates include:

- The Marine Protection Research and Sanctuaries Act of 1972 (Public Law 92-532)

  Gives the Secretary of Commerce the responsibility for conducting research and monitoring on the effects of ocean dumping (Section 201), and on the long-range effects of pollution and other human-induced impacts on the ocean ecosystem (Sec. 202).

- The Fishery Conservation and Management Act of 1976 (Public Law 94-265)

  Requires the Secretary of Commerce to operate a comprehensive fishery research program which shall include inter alia the impact of pollution upon fish (Sec. 304(e)).

- Fish and Wildlife Act of 1956

  Provides, in part, for assistance to be provided to the fishing industry in order to ensure economic and technical development, resource conservation, and resource management to assure the maximum sustainable production for the fishery (Sec. 742a).

- Fish and Wildlife Coordination Act of 1956 (16 U.S.C. 665)

  (NOAA responsibility via Reorganization Plan #4 of 1970). Requires the Secretary (of Interior) to make investigations to determine the effects of domestic sewage, mine, petroleum, industrial wastes, erosion silt, and other polluting substances on wildlife. Such studies shall include methods of preventing pollution.

- Sea Grant Program Improvement Act of 1976 (Public Law 94-461)

  Requires the Secretary of Commerce to identify specific national needs and problems with respect to ocean and coastal resources, and allows the Secretary to make grants or enter into contracts under this Section with respect to such needs or problems (Sec. 206(a)).

Deepwater Port Act (Public Law 93-627)

Directs the Administration to establish Environmental review criteria (Sec. 1505). Such criteria shall include the assessment of the potential polluting possibilities of the proposed port. Designation of an adjacent coastal State shall also be made by NOAA (Sec. 1508).

- Migratory Game Fish Study Act of 1959 (Public Law 89-359)

  Directs the Secretary of Commerce to undertake a comprehensive study of migratory fish of recreational importance (both catadromous and anadromous). The study shall include research on influences of natural and artificial environments including pollution (Sec. 760(e)).

- Anadromous Fish Conservation Act of 1965 (Public Law 89-304)

  Provides for research and recommendations regarding the reduction of pollutants injurious to fish and wildlife in interstate or navigable waters (Sec. 757(a) and Sec. 757(b)).

- Coastal Zone Management Act of 1972 as amended in 1976 (U.S.C. 1451-1464)

  Authorizes the Secretary of Commerce to conduct a program of research, study, and training to support the development and implementation of management programs (Sec. 1456(c)). Estuarine sanctuaries sections of the Law authorize the Secretary to make grants to coastal states for the purposes of acquiring, developing, or operating estuarine sanctuaries which should serve as natural field laboratories to study and gather data on the natural and human processes occurring within the estuaries of the Coastal Zone.

- Endangered Species Act of 1973

  Authorizes the Secretary of Commerce, with respect to any species over which program responsibilities were transferred pursuant to reorganization Plan Number 4 of 1970 to engage in research in order to determine whether such species should be listed as endangered or threatened (Sec. 1533(a)).

- The Farrington Act of 1947 (16 U.S.C. 758-758(d))

  Authorizes the Secretary of Commerce (via Reorganization Plan No. 4) to conduct fishing explorations and necessary related work (including oceanographic, biological, technological, statistical) to ensure maximum development and use of high-seas fishery resources.

- Agriculture Marketing Act of 1946 - (7 U.S.C. 1621-27)

  Authorizes the Secretary of Agriculture to engage in research involving other Federal and State agencies to assist in marketing, distribution, and production of agricultural products including fish and shellfish.

- The National Environmental Policy Act of 1969 (Public Law 91-190)

  Gives the agency three basic responsibilities under the Act:

  (1) that each Federal Agency is to use all available means to assure "productive and enjoyable harmony" between man and the environment and to promote efforts that will prevent or eliminate damage to the environment (Sec. 101).

  (2) to include with every major Federal action that affects the quality of the environment a detailed environmental impact statement that should include a description of the existing environment (Sec. 102(c)), and

  (3) under the same section the requirement of the agency to comment on statements issued by other agencies for which NOAA has jurisdiction by law or special expertise with respect to any environmental impact.

- Federal Water Pollution Control Act of 1972 as amended by The Clean Water Act of 1977 (Public Law 92-500 and P.L. 95-217)

  Although the major responsibility under this Act falls with the Administrator of EPA, the Act expressly encourages other Federal, State, and local agencies to cooperate in establishing National programs for the prevention, reduction, and elimination of pollution. This includes research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of pollution (Sec. 104(a)(1)). The use of NOAA's resources is specifically acknowledged in Section 104(a)(5). This section contains the requirement to establish, equip, and maintain a water quality surveillance system for the purpose of monitoring the quality of the navigable waters, the contiguous zone, and the oceans, using NOAA services. The requirement to establish an ocean monitoring network under Section 301(h) of the Clean Water Act of 1977 furthers NOAA's involvement in marine pollution activities. This section provides for a waiver of secondary treatment where it can be shown that there is no harm to the marine environment. It also requires the establishment of a monitoring system to detect any pollution of the environment.

- Marine Mammal Protection Act of 1972 (Public Law 92-522) (16 U.S.C. 1361-62 et seq) as amended by FCMA

  Requires the Secretary of Commerce to issue regulations on the taking of marine mammals. Such regulations shall include the potential effect of pollution on the species.

- Several lesser fishery-related research Acts:

  1. Gulf States Marine Fisheries Commission Act
  2. North Pacific Fisheries Act of 1974
  3. Atlantic States Marine Fisheries Commission Act

Note: Effective October 3, 1970, Reorganization Plan No. 4 of 1970 (84 Stat. 2090) transferred to the Secretary of Commerce the functions vested by law in the Bureau of Commercial Fisheries, and the functions vested by law in the Secretary of the Department of Interior, which were then administered through the Bureau of Commercial Fisheries. Also transferred to the Secretary of Commerce by this plan were the functions of Interior relating to migratory marine species of game fish as authorized by Public Law 86-359.

NOAA's involvement in monitoring of ocean pollution is carried out through the following programs:

Ocean Dumping Program

Goal: To establish a comprehensive and continuing program of monitoring and research on the effects of the dumping of waste materials into ocean waters.

This program addresses the following concerns:

1. The effect of ocean dumping on the health of the ocean,
2. the threat of ocean dumping on public health,
3. the threat of ocean dumping to local and regional ecosystems, and
4. the negative effect of ocean dumping on aesthetic and recreational uses of coastal and nearshore areas.

Objectives:

1. To determine the environmental effects of past and present dumping activities by making scientific investigations of current dumpsites. These will incude onsite field studies plus the laboratory and experimental studies required to interpret and support dumpsite specific work, as well as analysis of any historical data available.

2. To ascertain, by laboratory and field studies, the physical, chemical, and biological interactions between dumped materials and the affected oceanic environment, and to improve our understanding of the fate and pathways of dumped materials that affect the biological food chain.

3. To develop and implement monitoring procedures by which the effects of continuing, stopping, increasing, or decreasing dumping at particular dumpsites can be measured.

4. To develop scientifically sound criteria to assist in determining when dumped materials are unacceptably harmful to the environment, and when a dumpsite or region is degraded dangerously.

5. To develop selection criteria for disposal sites that will enable wastes to be dumped at disposal sites best able to accommodate them safely, and to predict the enviornmental effects of changing the input of dumped material at a dumpsite.

6. To make scientific investigations of possible new dumping procedures and techniques to determine their environmental suitability. These will include investigating the desirability of dumping in specified water types rather than within specified geographical boundaries.

National Sea Grant Program

The Office of Sea Grant awards grants for research and development, education and training, and advisory services in all fields related to the development and use of marine resources and the marine environment. The term marine environment is defined to include the oceans, the continental shelf of the United States, the Great Lakes, and the seabed and subsoil of the submarine areas adjacent to the coasts of the United States and its island territories to the depth of 200 meters, or beyond that limit, to waters that permit the use of natural resources.

The research program is applied to the following:

1. Development, conservation, and economic use of the resources of the marine environment (including definition and harvesting of natural stocks of living organisms and minerals, and aquaculture of commercially valuable species.

2. Marine technology and engineering.

3. Estuarine and coastal use (including recreation and other uses).

4. Economic, legal, medical, and sociological considerations related to the management and development of natural resources of the marine environment.

The education program emphasizes engineering over basic science and includes 2-year technician training programs. The total educational objective is very broad, encompassing training in law, economics, and administration as they apply to ocean-related problems.

NMFS Microconstituent Program

This program was established to determine on a sound scientific basis the occurrence and significance of contaminants in seafood and to protect the consumer, the industry, and the resource.

The program provides three related types of information that, considered together, permit a more accurate determination of the public health significance of microconstituents in fish and fishery products. They are:

1. The levels of contaminants in fish,
2. The chemical form and interaction of these contaminants,
3. The consumption for fishery products in the United States.

NMFS research on microconstituents is primarily conducted at its laboratories in Charleston, S.C., and Seattle, Wash. The microconstituent program provides important information to government regulatory agencies, such as the Food and Drug Administration (FDA), and the Environmental Protection Agency (EPA), for use in establishing guidelines to protect public health; to other NMFS researchers concerned with the harmful effect of contaminants on fish; to State, Federal, and international groups, and industry to aid them in the management of fisheries; and to the consumer to provide factual information on contaminants as they relate to human health and safety risk. The ongoing program objective is to continue to provide safe, wholesome, high-quality seafood products.

NMFS Ocean Pulse Program

This program has been designed to provide data that can be used to assess the relative condition of living resources and their habitats, and to predict the extent to which human activities are changing the productive systems in the coastal and estuarine waters along the northeast and middle Atlantic coast. The program will make use of traditional ecological methods of monitoring environmental changes, but emphasizes new, more efficient, and more sensitive methods. Pulse Program objectives are:

- A determination of the present status of preselected fishery habitats, including estuarine and coastal waters as well as the marine waters off the continental shelf of the northeastern and middle Atlantic States.
- Identification of the physiological/behavioral/morphological/genetic/ecological norms of the living resources of concern.
- Establishment of a coordinated standard system of long- and short-range monitoring of the condition of the marine resources and their habitats.
- Development of the ability to forecast the effects of degradation and to plan for enhancement or stabilization of the habitats as they are affected by humans.

Pulse is directed towards establishing useful baselines or benchmarks indicative of the present condition of the fishery and associated environments and providing these to management groups in order to document changes and to implement management activities that lead to rehabilitation of degraded habitats and prevent further deterioration from chronic and acute pollution.

APPENDIX B—Federal marine pollution monitoring projects funding for FY 1978, 79, and 80

Agency and program or project	Funding		
	FY 78	FY 79	FY 80
	(Thousands of dollars)		
EPA:			
Great Lakes Program	3,728	3,728	3,728
Chesapeake Programs	699	699	699
National Marine Pollution Monitoring Program (Mussell Watch)		350	350
Baseline Surveys and Monitoring of Ocean Dumping Sites	1,500	1,500	1,700
NPDES Compliance Monitoring	411	411	411
State and Interstate Agency Water Monitoring (106)	550	550	550
National Water Quality Surveillance System (NWQSS)	550	450	400
Subtotal:	7,438		
HEW:			
National Shellfish Sanitation Program	2,300	2,300	2,300
Pesticides and Metals in Fish Program	800	800	800
Market Basket Total Diet Program	5	5	5
Radionuclides in Food Program	5	5	5
Subtotal:	3,110		
DOI/BLM:			
South Texas OCS Submarine Banks Monitoring Study			1,000
Topographic Features Study - Gulf of Mexico	1,986	767	1,000
Eastern Gulf of Mexico Rig/Platform Monitoring		50	
South Atlantic OCS Satellite Oceanography	142		150
Benthic Recolonization Study in the Middle Atlantic Region	561		
Subtotal:	2,689		

Agency and program or project	Funding FY 78	FY 79	FY 80
	(Thousands of dollars)		
DOI/FWS:			
Sturgeon and Striped Bass in San Francisco Bay	250		
Introduction of Contaminants into Streams by Anadromous Fish	14		
Effects of Davis Besse Nuclear Powerplant on Lake Erie	48		
Great Lakes Surveillance	160		
National Pesticide Monitoring Network for Birds - Waterfowl	120*		
National Fresh Water Fish Monitoring Network - Collected in Estuaries	100	100	100
Environmental Effects of Trans-Alaska Pipeline	150		
Subtotal:	842		
DOI/USGS			
National Stream Quality Accounting Network (NASQUAN)	2,100	2,100	2,100
DOC/NOAA:			
Ocean Pulse		250	1,281
Ocean Dumping	400	500	600
Monitoring Organic Contaminants in Industrial Fish and Their Products	30		
Prince William Sound Hydrocarbon Monitoring	83	83	83
Biological Oceanography of Stressed Environments	226	226	226
Coastal Monitoring Assessment and Protection	136		
Long-Term Environmental Monitoring	75		
Monitoring Shellfish from Chesapeake Bay for Enteroviruses	34		
Molluscs as Indicator Organisms in Marine Benthic Communities	17		
Monitoring Polycyclic Hydrocarbons in Chesapeake Bay to Estimate Hazards	28		
Microconstituents	616	1,136	1,226
Subtotal:	1,645		
TOTAL:	17,824		

Report of the Subcommittee on

Research and Development

Working Paper 5
March 1979

John B. Slaughter
Subcommittee Chairman

Interagency Committee on Ocean Pollution Research, Development, and Monitoring

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Federal Coordinating Council for Science, Engineering, and Technology

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OCEAN POLLUTION RESEARCH AND DEVELOPMENT

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OCEAN POLLUTION RESEARCH AND DEVELOPMENT

The objective of the Subcommittee on Research and Development was to determine the extent to which ongoing Federal programs and existing facilities were meeting national needs and solving national problems related to ocean pollution. This task specifically grew out of Section 4(b)(2)(B) and Section 4(b)(3)(A) of the National Ocean Pollution Research and Development and Monitoring Planning Act of 1978 (Public Law 95-273). The Subcommittee was charged with identifying redundant programs of research and development and preparing recommendations regarding the need for additional programs and for better coordination of existing programs to ensure that the national needs would be met. It was intended that such recommendations include suggestions for appropriate changes in the overall Federal effort. The subcommittee was asked to assess the feasibility of accomplishing the research and development objectives, the time required to produce useful results, and the resources required for the program.

The Subcommittee depended largely on the questionnaires in which various agencies provided information on research facilities and research projects. This was particularly difficult, because the reporting was in different formats. Furthermore, the information proved difficult to assimilate, categorize, and assemble, because no general classification of research and development had been suggested as guidance. In particular, the determination of whether a program was research or monitoring, or neither, was highly subjective, owing to the nature of the available information. Moreover, information on national needs was received at a late date and precipitated more rapid analysis of the data and development of recommendations than otherwise would have been the case. As a consequence, how this Subcommittee has met its responsibilities depended largely on the nature and timeliness of information provided by other activities beyond the Subcommittee's control.

In assessing the existing and proposed R&D programs on oceanic pollution, the Subcommittee recognized that certain research tasks, although not originally conceived to address specific oceanic pollution problems, were nevertheless essential for solving such problems. For example, studies of the speed and direction of water movement, the marine chemical characteristics of injected material, and air/sea transfer processes are but a representative few oceanographic research activities. The results of such studies bear directly on being able to predict the consequences of pollution on the marine environment. Accordingly, in deciding whether a reported research project could be classified as pollution oriented, considerable weight was given to the applicability of results versus the identification of a specific oceanic pollutant or problem. This was particularly the case with National Science Foundation projects.

An analogous problem arises in attempting to differentiate between research and monitoring projects. Basic research studies in oceanography often require a data base for statistical analyses. In some cases, the establishment of this data base appears strikingly similar to monitoring, and, if evaluated alone, might be classified as monitoring. The Subcommittee was careful not to reject such efforts when they were clearly an integral segment of the research.

Key Definitions

The Subcommittee also kept in mind the key definitions that were agreed upon at the October 25, 1978, meeting of the Interagency Committee on Ocean Pollution Research and Development and Monitoring. These are:

I. Marine Environment -- the coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder), strongly influenced by each other in proximity to the shorelines of the several coastal States, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. Also included are the waters of the Great Lakes, to the international boundary between the United States and Canada, the seabed, subsoil, and waters of the territorial sea of the United States; the waters of any zone over which the United States asserts exclusive fishery management authority; the waters of the high seas; and the seabed and subsoil of and beyond the Outer Continental Shelf.

II. Ocean Pollution -- the results of human activities in the marine environment that cause, directly or indirectly, deleterious effects on the condition of the ecosystem, hazards to human health, or reductions in socioeconomic or esthetic quality of the marine environment.

III. Research -- with respect to ocean pollution, studies, scientific experimentation, investigations, and surveys:

A. to improve man's basic understanding of the natural processes of the ocean with respect to ocean pollution, including chemistry, currents, seasonal changes, ocean-atmosphere interactions, benthic-water column interactions, living population behavior and dynamics;

B. to identify the behavior, fate, and effects of pollutants and potential pollutants, including their rates of introduction into the marine environment, chemical and physical behavior, toxicity, assimilation rates, and chemical, physical and biological concentration and degradation modes; and

C. to evaluate the deleterious effects of pollutants and potential pollutants on the condition of the ecosystem, on human health, and on the socioeconomic and esthetic quality of the marine environment.

IV. Technology development -- with respect to ocean pollution, efforts to provide the technology needed to limit the introduction of pollutants into the marine environment and to mitigate the effects of chronic and catastrophic introduction of pollutants into the marine environment; and to provide the analytical methods, instrumentation, and equipment necessary for these efforts and for ocean pollution research and monitoring.

V. Monitoring -- with respect to ocean pollution, the systematic measurement of marine conditions over sufficient periods of time:

A. to establish existing levels of marine pollutants;

B. to assess potential hazards to human health;

C. to assess changes in ecosystem health and in marine biota relevant to their use as living resources; and

D. to assess the effectiveness of measures taken for the reduction of marine pollution.

Note: Ocean pollution monitoring does not include basic research into natural processes and phenomena.

Approach to Examination of Federal Program

Any examination of the Federal program of ocean pollution research and development (R&D) leads one to the inescapable conclusion that important research and technology questions are being examined and that the results of these efforts will lead to a better understanding and, perhaps, solutions to pressing problems. It is less clear, however, that the work represents the right things that need to be done or that wasteful duplication is not occurring. Trying to develop precise answers to these matters is difficult and, in all probability, an ineffective way to spend time and energy. Rather, it is more likely that useful results will emerge from an attempt to understand what is being accomplished, what is being planned, and what changes should be made to these plans in order to address key areas where knowledge and/or technology is insufficient.

For a topic as broad as ocean pollution, the definition and management of an appropriate program of research and development is very difficult. It is made more difficult in the context of the Federal arena, because of the mystifying interleaving and interdependent nature of the missions of the various agencies involved in matters directly or indirectly related to ocean pollution. The specific task of the Subcommittee to assess the ongoing R&D program is also complicated by the disquieting knowledge that those programs that have been submitted on the inventory forms represent but a fraction of the Federal efforts and a much lesser fraction of the national efforts supported by State and local agencies, industry, and even Federal organizations that have not reported their activities. Consequently, any conclusions that may be drawn from this assessment are at best suggestive and should be so recognized.

For the above reasons, this document does not completely provide the answers to the questions raised in the charge to the Subcommittee. Instead, we have attempted to do the following things in this report:

(1) Provide an interpretation of R&D needs as seen by scientists who have studied the problems of ocean pollution and by persons who participated in the Workshop on National Needs and Priorities.

(2) Provide an overview of the programs underway and (to the extent known) planned in several of the Federal agencies engaged in marine pollution R&D. (Although each such agency was requested to provide this information, the responses were neither complete nor uniform.)

(3) Provide general recommendations on the directions for future R&D efforts related to marine pollution.

It should be noted at the outset that the Subcommittee made no effort to analyze the quality, sufficiency, or effectiveness of the facilities reported in the questionnaires. It was our unanimous opinion thatthe reports provided too little information and failed to encompass most of the facilities for ocean R&D pollution work. For example, any listing of facilities that fails to include the resources of Scripps Institution of Oceanography or Woods Hole Oceanographic Institution (both supported largely by Federal funds) is an unreal list that does not deserve critical study. Similarly, no meaningful judgments can be made about the numbers of workers in marine pollution R&D from the data provided; therefore, none has been provided. If information in these categories is required in the future, a more careful process must be designed for acquiring meaningful inputs.

In the next section of this report we have attempted to describe some of the relevant R&D issues concerned with marine pollution. We have drawn heavily on the results of the Estes Park Workshop, the preliminary report of the National Needs and Problems Workshop, and the book, The Health of the Oceans, by Edward D. Goldberg, UNESCO Press, Paris, 1976.

Summary of R&D Needs and Activities

The study of ocean pollution suggests many questions. Paramount among them is the question of the ability and capacity of the world's oceans to assimilate natural and manmade inputs and to respond to these inputs in such a manner that the resultant effect on the uses of the ocean is negligible. All other research issues are elements of this principal one. The sources, transport, fates, and effects of marine pollutants are but components of the basic research needed to understand the behavior of the ocean under pollution stress. Because of the complexity of the problem, marine pollution R&D efforts must be accomplished by attacking individual problems and obtaining incremental increases in knowledge. Consequently, research projects typically address specific topics such as bioaccumulation in certain marine organisms, or the fate of a halogenated hydrocarbon such as DDT in a planktonic environment.

For a number of years, researchers have been experimenting on the scientific problems of ocean pollution. Significant increases in the base of knowledge have occurred. Research has identified new and more complex issues, and new initiatives have been started to address them. The physics and chemistry of the world's oceans are still poorly understood; consequently, most theories about the transport and consequences of toxic elements in the marine environment are yet unconfirmed. Our knowledge is incomplete about what happens to pollutants once they have been introduced into the oceans. The extent to which the pollutants change form, are absorbed by the sediments, are accumulated by marine organisms, or become transmitted into the atmosphere are areas in which R&D questions exist. To better understand the processes of ocean pollution, it is necessary to understand more about what happens to specific pollutants once they enter the water. Some of them become more concentrated or become more toxic. Some pollutants degenerate to totally harmless substances. Underlying all this uncertainty is the inability to monitor and measure accurately the concentrations and effects of the pollutants.

A very important consideration in understanding ocean pollution and identifying R&D needs is the recognition that the types and fates of pollutants depend on whether consideration is being given to the coastal ocean or the open ocean. By the coastal ocean we refer to that part of the ocean that includes estuaries, lagoons, and waters along the shorelines and over the continental rises and slopes. These areas are characterized by the fact that rivers, ships, the atmosphere, industry, and people introduce materials and substances that directly pollute the waters. An important feature of coastal waters is that they are the sites of high biological activity and the effects of pollution can have significant economic as well as ecological impacts.

Bioaccumulation, the process by which marine organisms accumulate toxic substances from the seawater, particularly in coastal regions, is an area that is undergoing considerable research and requires further examination. Much needs to be understood about this process and how certain organisms can accumulate materials at even very low concentrations. As a result of bioaccumulation, marine organisms can act as transport agents of human wastes and pollutants.

Pollutants display different characteristics in the open ocean than in coastal regions. Some toxic substances that find their entry to the ocean by first entering the coastal waters through sewer or industrial outfalls or that enter the surface waters of the open ocean as atmospheric gases ultimately end up in the deep ocean by mixing or biological activity. This process is a gradual one that may require as much as a decade to complete. Pollutants accumulate in the sediments of the open ocean much more slowly than in coastal waters. Consequently, most of the human wastes in the open ocean can still be found in the water column rather than in the sediments.

It is important to realize that pollution of the oceans is a global problem that requires the involvement and cooperation of many nations to arrest. Particular problems may require the participation of specific groups of countries that have common characteristics, e.g., those nations that transport oil on the ocean or those countries that deposit nuclear wastes at sea. Although the contribution of toxic substances by a single country may be small, the total deposition of pollutants by a group of countries may be quite significant. The problem caused by toxic substances introduced into the ocean from several locales may not be noticed immediately, but the cumulative effect may be enormous after the passage of decades. This is particularly true of some of the halogenated hydrocarbons and for metals such as the transuranics, those metals heavier than uranium in the periodic table. Nations must work together in applying R&D to prevent the leakage of these substances into the world's oceans and to mitigate the effects of these toxic substances that have already found their way into the marine environment.

A major problem facing the researcher is to obtain a more complete understanding of the natural processes whereby foreign substances enter the marine environment. The knowledge of the flux of a particular material introduced by human activities in relation to that which occurs naturally is important in order to ascertain the value of a research objective devoted to that substance. The contributions of rivers, winds, precipitation, and glaciers must be better understood before one can assess adequately the effects of the increments due to human activities. Although the total flow of materials into environmental reservoirs by anthropogenic activities is about 10 percent of that which ooccurs naturally, some specific toxicants are present in the ocean principally, if not fully, because of human actions. Examples include the polychlorobiphenyls (PCBs), carbon dioxide from fossil fuel burning, and lead from automotive emissions. Research is required to understand better the dynamics by which these chemicals are transmitted to the oceans and their levels in the marine environment.

Indirect approaches are often required to measure the concentrations of many pollutants. Chemical analysis of coastal sediments can often provide the best evidence of the level of concentration of a pollutant. Ice cores in the polar seas are also a prime source of information. Coral layers and marine organisms are often prime sources for records of pollutant deposition in ocean waters. The discovery of effective measures of pollution is an important R&D thrust.

A class of pollutants found widespread in the world's oceans are the halogenated hydrocarbons such as DDT and the PCBs. These pollutants are encountered in all forms of marine organisms and appear to enter the oceans in gaseous form by travel through the troposphere. Other members of this family include the chlorofluorocarbons used as aerosol propellants, dry cleaning fluids, and industrial solvents. These low molecular weight hydrocarbons are widely found in coastal regions and the surface layers of the open ocean. Because of their persistence, considerable research should be directed toward their long-term effect on marine life.

A number of studies have been made on the transport and fate of the chlorinated hydrocarbons. An important conclusion of this work is that substantial amounts of these chemicals can be found in the coastal sediments of the ocean. It is thought that a principal path from the surface to the sediments is provided by suspended particulates on which the hydrocarbons become adsorbed and are carried to the sediments.

As mentioned earlier, DDT residues and PCBs are found in many forms of marine life. The concentrations in organisms depend on many environmental factors, such as wind patterns, salinity, currents, temperature, the biological productivity in the region, and the types of outfalls from the adjacent land areas. Our knowledge of the basic physiology and biochemistry of marine organisms and the toxic effects of DDT and PCBs on these organisms is insufficient to allow us to understand the sometimes subtle, long-term effects on marine life. From laboratory experiments we have learned that halogenated hydrocarbons can alter the character and composition of phytoplankton communities by affecting certain species. Extrapolation of these laboratory results to life in a natural environment has not been accomplished.

Lower molecular weight halogenated hydrocarbons can also affect the process of fermentation whether it be for the processing of sewage or the making of wine. They affect fermentation by radically altering the methyl transfer processes. Laboratory experiments are needed to increase our knowledge about how the fermentation process is affected and the contribution of specific toxic agents to the disorder. Research is required to provide answers about the behavior of each toxic compound acting singly and in conjunction with one or more other pollutants.

A global problem of marine pollution is the release of radioactive materials to the oceans from the detonation of nuclear devices or the waste byproducts from nuclear powerplants. Of concern are both the artificial radionuclides that result from fission products or as induced radioactive species such as zinc-65, strontium-90, and cesium-137 and the transuranics (chemical elements with atomic numbers greater than 92). Much focus is being given to these latter elements, because of their ever-increasing quantity. Transuranics are produced by nuclear reactors and weapons and consist of such highly toxic elements as plutonium, neptunium, americium, and curium. The biogeochemistry of these elements is not well enough understood to allow meaningful estimates of the acceptable quantities in the ocean and the imapct of these pollutants on marine life or the use of the impacted waters by humans. The problems presented by the presence of transuranic elements is particularly acute in coastal waters and could be exacerbated by the continued development of nuclear powerplants in coastal regions or in offshore areas as they are now being conceived. If the oceans are to be potential repositories for fission products and nuclear powerplant wastes, considerable research will be required before the consequences of such an action can be predicted and controlled.

Radioactive materials can be introduced into the ocean environment in a number of ways. The detonation of nuclear devices underwater is a principal source. Although such a detonation initially places the radioactive substances in a fairly localized region, subsequent mixing and circulation of the ocean waters cause the toxic elements to be distributed over very large regions. Land-based and even ship-based nuclear reactors also contribute to the quantities of radioactive nuclides that are to be found in the ocean. Plutonium-238, chiefly used for fuel in electrical and heating plants, is expected to continue as an important nuclear fuel. The transport of plutonium within the United States will unavoidably allow some leakage to the environment. Understanding the pathways by which plutonium travels to the coastal regions and ultimately returns in a form that affects humans is a very important area for research.

Pollution of the ocean by the introduction of metals is another area that needs research. Coastal waters have become polluted, because of river runoff from industrial and residential waste outfalls, fossil-fuel combustion byproducts, and lead from automobile exhausts. The heavy metals (iron, lead, chromium, copper, zinc, cadmium, silver, nickel, cobalt, manganese, vanadium, and mercury) enter the marine environment through a variety of paths and may exist in one of these chemical states in the water: particulate, colloidal, and dissolved. Resident marine organisms accumulate some metallic forms; the waters or sediments take up others.

Sampling and analysis techniques for trace metals in the dissolved and particulate states need to be developed to improve our understanding of their chemical behavior in seawater. The effects of these elements on organisms and phytoplankton communities need systematic study and observation. Other areas of research include studies of the natural and anthropogenic fluxes and paths, and sediment and water column concentrations in both coastal and open ocean, and the determination of the chemical speciation of the trace metals of greatest concern.

Perhaps no other form of ocean pollution is as well known or recognized as that due to oil or other petroleum-based substances in the water. Not only does the introduction of petroleum hydrocarbons stain and soil the beaches, structures, and vessels, it also kills or harms fishes and birds that ingest the substances or inhabit the polluted area. The main source of human-induced petroleum pollution are ships whose discharges, whether inadvertent or intentional, cause the dispersion of crude oil and engine wastes. They create particular problems in the continental shelf regions and frequently in estuarine waters. Although marine pollution by petroleum hydrocarbons is highly visible, it may not be the most critical problem in the near future. However, the long-lasting effects of petroleum in the water makes it necessary that we understand its impact upon marine plants and animals.

There are natural sources in addition to the petroleum hydrocarbons introduced by human activities. These include hydrocarbons produced by marine organisms and hydrocarbons that seep into the water through the sea floor. Natural seepage varies as a result of geographical, geological, and geochemical conditions. Areas of high tectonic activity tend to have higher seepage fluxes. The geology and geophysics of the various ocean regions represent important research areas for better understanding of this process.

The fates of petroleum discharges are poorly understood. Possible processes include evaporation, solution, emulsification, sedimentation, oxidation, and decomposition by microbiological activity. Which of these processes will govern the fate depends upon many factors: temperature, sea state, nutrients, and molecular weight of the petroleum substance. Research into each of these processes is needed in order to understand more fully the means by which the ocean cleanses itself of the toxic substance.

Our knowledge concerning ocean pollution is valid only for those substances that have been studied relative to their behavior and effects when introduced into the ocean. Very little has been done in terms of predicting what other substances may some day achieve unacceptable levels in our marine environment. We do not know what new materials ultimately may have deleterious effects and dangerous consequences on our use of the oceans or the resources within them. We are unaware of how these substances may be transported, what will be their fates, and what regions of the world's oceans will be most affected. These and similar questions represent the challenge facing the Federal Government in developing a long-range research and development plan to combat ocean pollution.

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